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AGRICULTURAL ENGINEERING

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The Needs and Uses of Ultraviolet Radiation in Agriculture *John E. Nicholas*

Ag Engineers Develop Functional Design of a Milkhouse *James S. Boyd*

Adapting Cribs for the Drying of High-Moisture Ear Corn *Leo E. Holman*

Preservative Treatment of Fence Posts with Water-Soluble Salts *Geo. H. Dunkelberg*

Means for Determining Temperature Gradient in Hay *John B. Dobie*

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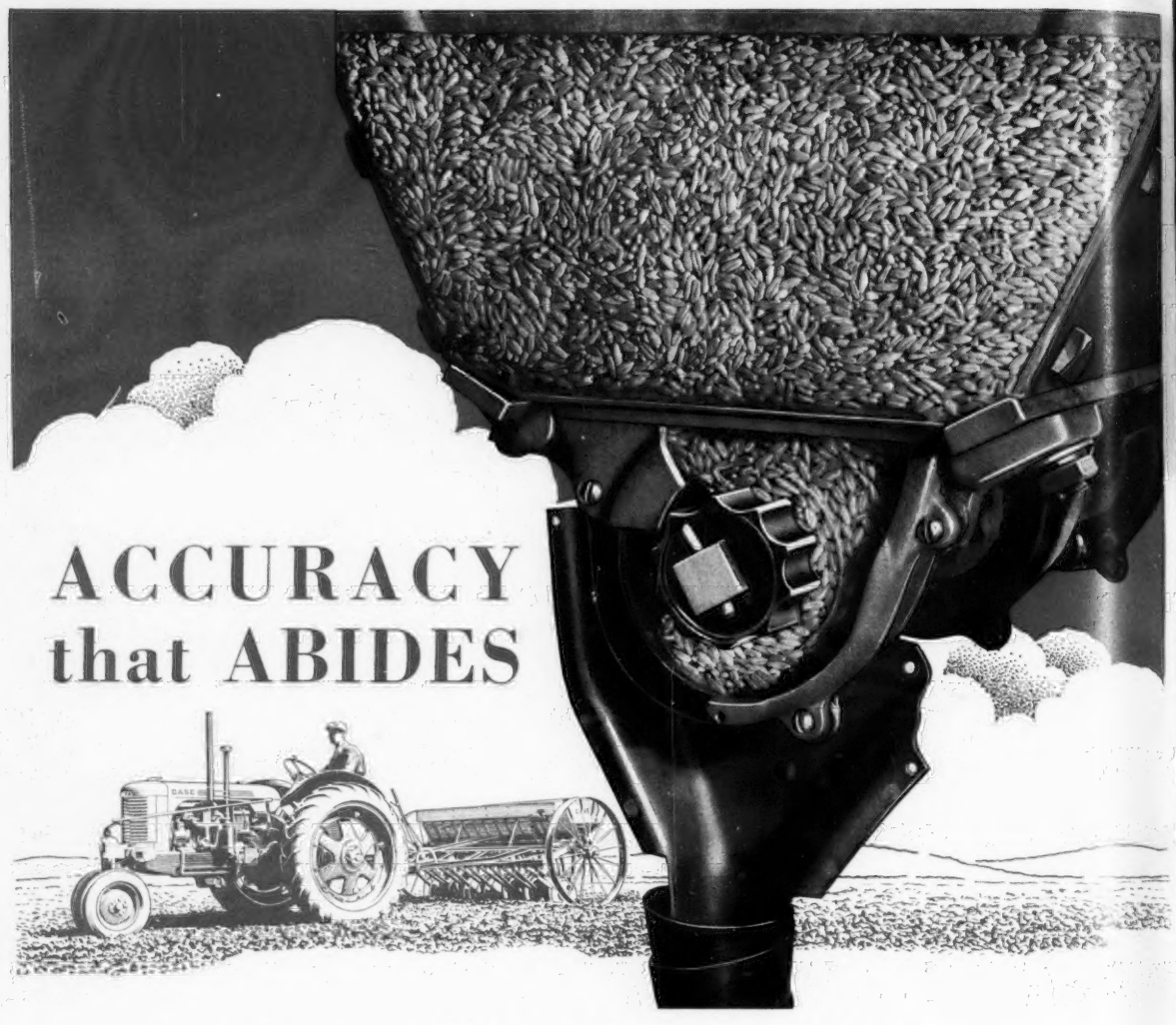

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EDITORIAL

Interest in Chemurgy

MANY agricultural engineers are in close agreement with farm chemurgic philosophies of abundant low-cost, high-quality farm production; maximum effective utilization of that production, and conservation of natural resources.

Because most agricultural engineers are necessarily preoccupied with other matters, it seems desirable to review the nature of agricultural engineering technical interest in chemurgy.

We are naturally interested in and will find out about and use as occasion arises, the improved and new engineering materials resulting from chemurgic progress. We have learned to look for them in such materials as glues, paints, plastics, structural laminates and panels, thermal and electrical insulation, and in metals processed with the aid of farm products.

We are interested in the new chemicals which chemurgic progress makes available for farm use, and in the influence of such chemicals on farm equipment and structural requirements. We have learned to expect new problems in providing suitable farm facilities for storing and for applying new insecticides, fungicides, herbicides, and other new chemicals useful in farm production operations.

A third technical interest of agricultural engineers in farm chemurgic progress may be slower in development, if not given conscious attention. It is in helping farmers to meet the raw material requirements of the farm product processing industries.

Agricultural engineers have shared with the engineers and chemists of the process industries, an appreciation that successful processing often depends on meeting quite definite specifications as to the quality, condition, quantity, delivery, and cost of the materials to be processed.

It does not appear that many of those concerned in the process industries have shared a corresponding appreciation of the things agricultural engineers might do to help farmers meet organic raw material delivery specifications.

Processors seem prone to be guided by the "status quo" in farm production and marketing; to base their operations on existing markets and market grades of farm products, or on the collected wastes of established processes.

This is a natural and sound development, as far as it goes. It is evident that it does not go very far toward the maximum development and utilization of the commodities and residues, present and potential, which agriculture is producing or might produce from present crops, improved varieties, or new crops and livestock.

It does little toward upgrading the values of the low-value or nuisance residues of farm production which offer most room for upgrading.

There are various good reasons for agricultural engineers and those concerned in industries processing farm products not having collaborated extensively up to the present.

It is a demonstrated fact, however, that the application of agricultural engineering can do a great deal to influence the physical, chemical, and biological properties, cleanliness, concentration, time, form, quantity, and cost of delivery of agricultural commodities and residues for use as raw materials in the processing industries.

Engineering is involved in the soil conservation, tillage, pest control, harvesting, handling, separation, cleaning, drying, grading, refrigeration, packaging, storage, and delivery factors influencing farm capacity to satisfy the material requirements of farm product processors.

In some cases further preliminary processing on farms may be made practicable by engineering, to reduce transportation costs, bulk storage, and processing waste problems, and to leave on farms materials of greater value there than elsewhere.

And the engineering planning of farm operations in relation to mechanical, structural, and electrical operating equipment is pre-eminently the field of agricultural engineering.

While some support and personnel have been found for agricultural engineering work toward more fully satisfying the raw material requirements of the processing industries, it amounts to only a small start.

And while agricultural engineers are already well occupied with recognized equipment application, refinement, and new development problems, they are alert to new opportunities to help farmers serve present and potential markets.

This leads us to believe that chemurgic progress, and the over-all economic service rendered by farmers, might be given a further boost by a fairly simple expedient. If more of the processors will make known to agricultural engineers their detailed specifications and tolerances for agricultural raw materials for their present or proposed processing operations, some agricultural engineers may be able to develop and introduce ways and means of better meeting those specifications.

Considerations in Foreign Aid

AT LEAST two persons — one a member of the American Society of Agricultural Engineers — have had occasion recently to testify before the U. S. Senate Foreign Relations Committee in connection with its study of the European Recovery Program. They represented significant numbers of responsible American farmers and business men in presenting viewpoints on the Marshall Plan. In doing so they emphasized two points which surprisingly have not been adequately considered in our previous foreign aid programs.

Paul M. Mulliken, executive secretary, National Retail Farm Equipment Assn., presented a concrete plan to collect and make available serviceable animal-drawn farm implements now idle on American farms, and suited to use on the prevalent small European farms with the man power and animal power there available. Agricultural engineers will readily see the point of the following two paragraphs from his statement:

"It should be most readily apparent that modern power farm equipment such as is currently being built by our factories would be neither practical nor feasible on farms comprising 5, 24 or even 35 acres where the individual fields would be still smaller. The knowledge of farmers' needs possessed by the farm equipment retailers of the United States convinces us that exporting huge quantities of tractors, combines, pick-up balers, and other power farm equipment to Europe is unsound. Even if ample supplies of fuel were available, there would be a shortage of trained operators, skilled mechanics, and adequate service facilities. This was proven in innumerable instances under the UNRRA program.

"We believe that it is an unsound practice to attempt to completely mechanize western European agriculture overnight. Farm mechanization must be a progressive movement just as it has been here in the United States. We began to use power farming methods before World War I and haven't yet completed the job after more than a third of a century."

Here is an example, in one field, of the plain fact that the products of modern American technology and industry are not miracle-working universal tools. They can contribute to efficient production and economic recovery only when they can be fully and intelligently utilized under the conditions for which designed, to do a specific job which is one link in the chain of events necessary to efficient, specialized economic production and distribution. In most of the countries which need our help for recovery, conditions favorable to the effective use of our most modern equipment simply do not exist and cannot be quickly brought about.

It is beyond the capacity of a 50-hp tractor, or even atomic power, to quickly change a peasant laborer, follower and victim of the prevalent ideology in his area, into a self-supporting, self-respecting, independent thinking, public-spirited practitioner of the abundant life for all. A good one-horse plow or hand hoe might readily be of far greater help to him to take one short step in that direction. Genuine help to other countries would naturally start with *(Continued on page 178)*

Announcing another new GE Farm Program

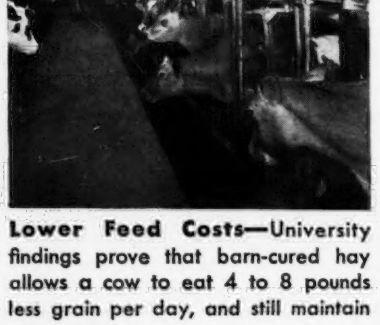
"Green Hay"

THAT'S THE TITLE of the third program in General Electric's new farm electrification campaign, **More Power to the American Farmer!** And it's being released *now* through local G-E Farm and Home Dealers and distributors. Its purpose is to help you show farmers all over the country the benefits they will derive from curing hay in the barn rather than in the field.

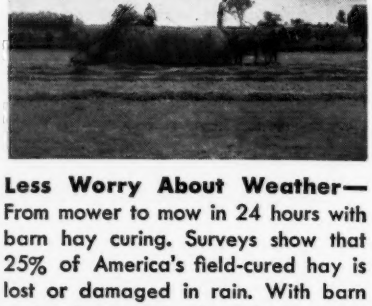
The program features **"Green Hay,"** a sound and color motion picture designed for presentation at farm meetings. This is supplemented by an attractive booklet for distribution to members of the audience at these meetings to summarize for them the important points of the film. Here are some of the big advantages this motion picture highlights—advantages for the farmer who barn-cures his hay:

Economical Operation—Electric power to drive a blower in the mow costs only 75 cents to $1.50 per ton for the entire curing period. Necessary ducts and vents can be made out of cheap lumber, no special carpentry skill required.

Better Quality Hay—Government tests show barn-cured hay is greener, more leafy than field-cured hay, and contains more proteins and carotene for better milk and meat production.



Lower Feed Costs—University findings prove that barn-cured hay allows a cow to eat 4 to 8 pounds less grain per day, and still maintain 50 pounds daily milk production. Grain savings run to $500 a year for 25 cows.



Less Worry About Weather—From mower to mow in 24 hours with barn hay curing. Surveys show that 25% of America's field-cured hay is lost or damaged in rain. With barn curing, hay can be brought in out of the rain.

Less Worry about Fire Hazard—Cool air blowing through hay prevents hot spots, and practically eliminates threat of spontaneous combustion.

Your G-E Farm and Home Dealer or distributor invites your active co-operation in setting up farm meetings in your area to present this program. The first two programs in the **More Power to the American Farmer** campaign, **"Wired for Life"** and **"Running Water on the Farm"** are still available, too. See your dealer or distributor *today!* Get the ball rolling in your community. *Farm Industry Division, General Electric Company, Schenectady 5, N. Y.*

GENERAL ELECTRIC

AGRICULTURAL ENGINEERING

VOL. 29 APRIL, 1948 NO. 4

Radiation Uses and Needs in Agriculture

By John E. Nicholas

MEMBER A.S.A.E.

AGRICULTURE is our basic industry, the principal function of which is the production of food from plants. Plants are requisites to man's existence. The food that he eats comes either directly or indirectly from plants. Much of his clothing comes from them, and plant products are used to a considerable extent for man and animal shelter and for manifold other purposes. Anything, therefore, that interferes seriously with man's attempt to grow crops interferes with the existence of the human race.

It is obvious that among the greatest hazards in crop production are unfavorable weather, plagues of insect pests, and plant disease epidemics. Any one of the three can upset the calculations of crop production with catastrophic suddenness. Whether the principal aim is maximum total production in a country as a whole, restricted total production with efficient production per unit area, or stability of production, violent and unexpected fluctuations are most likely to be caused by weather, pests, or diseases. This has been true for centuries, and despite man's best efforts to minimize the effects of these destructive agents through science, they still provide problems that challenge our intelligence and ingenuity.

Great progress has been made in devising methods for preventing destructive diseases, but despite all the advances, diseases still cost the farmers of the United States about a billion dollars annually[1*]. In recent years, studies of phenomena accompanying application of high-frequency currents to biological materials, such as small animals, insect pests, bacteria, fungi, plants, seeds, etc., have uncovered methods of promising practical usefulness[2]. Much research work has already been done on the action of various types of radiant energy, such as gamma, X, and Roentgen rays, radium emanation, ultraviolet rays, visible light spectrum, and infrared light on living things. (See appended references 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19).

ULTRAVIOLET RADIATION IN AGRICULTURE

The effect of radiation, in general, is directly proportional to its absorption. It is now generally accepted that nearly all bacteria and fungi may be killed or attenuated by ultraviolet energy of certain wave lengths but that different species vary considerably in their rate of destruction.

Radiation from mercury lamps, which produce rays[20] largely in the region of 2537 A (Angstrom units), have the highest bactericidal properties and the least erythemal effect. Such lamps[13] recently have found extensive use in the sterilization of air and of surfaces of contaminated rooms, food wrappers, food, and liquid containers.

Thus in agriculture we have already put this type of radiation to use in poultry laying houses, meat-aging rooms in locker plants, food storage rooms, and small animal pens. Use of radiant lamps of this type may well be extended into milkhouses and milk utensil racks, calf pens and pig litter colony houses, brooder houses and incubators, isolation wards for groups of young or sick animals, cheese-aging and storage rooms, silos and grain bins, clothes closets and washrooms, shoe trees for the farmer, and milk pasteurizers.

Middle Ultraviolet Rays. The type of radiation which most effectively produces erythemal rays (sun tan) has its value in the production of vitamin D in living tissue of the skin of animals, the epidermis of plants, and in non-living materials[21]. Its use in supplementing natural vitamin D for fowls or farm animals, as well as in the irradiation of animal foods, deserves great consideration.

Black Light Radiation. All substances absorb light, usually over a characteristic range of wave lengths, and many emit or re-emit such radiation. This emission phenomenon is known as luminescence[22]. Luminescence is a property of solids, liquids, and gases and may be divided into (a) fluorescence, if it lasts during the period of excitation only, and (b) phosphorescence, if it persists when the exciting source is removed. The wave length, 3650 A, is the principal line which is high in effectiveness for the usual fluorescent materials.

Some practical uses of fluorescence on the farm and in the handling of farm products are in differentiating various strains of grains; in classifying sound seeds and in the removal of old or damaged seeds; in determining the presence of bacteria or molds produced by storage on grains, seeds, foods, or other products; in sorting potatoes, beans, fruits, berries, and other crops; in examining the hides, hoofs, and wools of animals, and feathers of fowls for pathologic conditions, especially of a fungus nature, and in detection of molding in grain and fodder; in comparing oils, fats, and fertilizers, and in candling eggs, etc.

An application of radiant energy in brooding chicks. (Date, January 1942. Average temperature, 12 F outdoors)

INFRARED RADIATION

Electrical energy in the form of infrared rays[19] offers a convenient and flexible method of drying or therapy in that a suitable degree of heat, both as to intensity and amount, can be easily obtained. The efficiency of process drying or body therapy by the infrared rays obtainable from heat lamps is due in large part to the penetrating characteristics of wave lengths between 6,500 and 14,000 A.

Present, practical, and accepted applications of radiant heating in agricultural practices include its use in brooders for

This paper was presented at the winter meeting of the American Society of Agricultural Engineers at Chicago, Ill., December, 1947, as a contribution of the Rural Electric Division.

JOHN E. NICHOLAS is professor of agricultural engineering, Pennsylvania State College, State College, Pa.

*Superscript numbers refer to appended references.

chicks and pigs, in animal and human therapy, in supplemental heaters, in dehydration of fruits and vegetables, in sexual stimulation of fowls, in cotton drying during the ginning process, in orchard frost prevention[27], and in farmhouse heating.

The flexibility and the ease of control in amount and intensity of infrared radiation, as obtained from present types of available lamps, forcibly suggest two additional applications. One is for infrared drying of newly threshed or combined grains and seeds before storage, to prevent spoilage from excess moisture and possibly to reduce contamination from smut, rusts, or fungi. It is in this field of application that infrared radiant energy offers one of the most useful, beneficial, and efficient services it can render. The other is for the conditioning for safe storage of forage crops. The use of infrared radiation for drying of hay, because of inherent advantages over the use of blown air, deserves our most careful consideration. The combined use of infrared and ultraviolet rays for conditioning, disinfesting, and disinfecting grains and forage challenges all our talents and efforts.

HIGH-FREQUENCY USES IN AGRICULTURE

The use of high-frequency fields in agriculture may include applications to biological materials such as bacteria, insect pests, and animal organisms, and to plants and plant parts, including seeds and plant tumor tissues.

Investigators the world over have shown that insect pests, fungi. and bacteria may be destroyed by radiant energy or heat induced by the passage of electronic radiation. Damage caused by various cereal and grain weevils can be controlled. Wood-destroying fungi may be destroyed. Seed-born pathogenes (bacteria and fungi) may be destroyed on or in seeds, without injury to the power of germination. Work has been done with high-frequency electrostatic fields for the sterilization of insects in packaged materials, particularly stored foods and feeds. The term sterilization in this sense means the killing of insects in the various media. However, in the application of high-frequency radiation "secondary effects" are possible, such as modification of rates of reproduction or rates of development of plants and animals and the development of new breeds or species.[28]

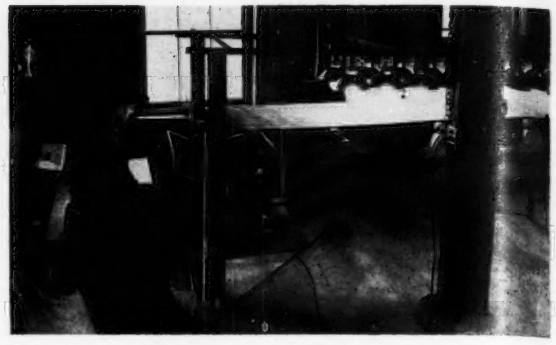
The application of high-frequency radiation to problems in biology has occupied the attention of a great many workers in medicine, microbiology, plant physiology, and pathology, and more recently entomologists have been interested in developing electronic control of insect and small animal pests.

Effects of High-Frequency on Men and Animals. Men and animals when exposed to high-frequency radiation are found to respond to it by a rise in body temperature. Artificial production of fever in man or animal thus can easily be accomplished by means of ultrashort currents employed as a therapeutic agent.

Effects on Insects. The effects produced by high-frequency currents on insects are obviously of great economic importance. Bean weevils and flour moths have been killed. Grubs of the Japanese beetle subjected to oscillating current of 3,000,000 cycles per second (100 meters) died in 60 to 180 sec when subjected to voltage gradients of 4,000 and 6,000 v per in, respectively. The adults, larvae, and pupae of insects feeding on stored products have been successfully eliminated by exposures to high-frequency fields. All stages of bean weevil were killed without harming the seed when exposed to a field strength of 4,000 v per in.

Mites, which are more resistant than weevils, when exposed to electro-magnetic waves of 60,000,000 cycles per sec (5 m) and a voltage gradient of 8,000 v per in were found to perish in 2 min.

Effects on Plants and Seeds. The effect of high-frequency currents on seeds has been found to definitely stimulate germination under some conditions. Work with frequencies from 750,000 to 14,778,000 cycles per second were observed by Headlee[23]. No injury to wheat seeds within the range of 750,000 to 3,000,000 cycles per second was noted, even at 80 min exposure. Kuperman[24] investigating the effect of high-frequency currents of 7 to 8 m with a voltage gradient of



Infrared rays supply the energy necessary for drying seed on this belt-type drier. The operation of this machine may be made automatic to meet varying seed moisture conditions

1,200 v per sq cm on yield, weight and general growth of cucumbers, tomato and cotton seed, found that cucumbers treated for 10 sec showed an average of 23 per cent increase in yield per plant, as well as an increase in dry weight of plants. Seeds treated for 5 sec gave plants which began to bear fruit nine days earlier than the checks.

Tomato seeds exposed for 5 to 10 sec, at the same voltage gradient, began to fruit 11 days earlier than the checks. Cotton seeds treated for 2 to 5 sec gave plants that formed flower buds 8 to 10 days earlier than the checks.

Webber et al[25] report the results of high-frequency radiation on adults and larvae of flour beetle. The insects were introduced into a standard package of plain cardboard containing 147 g of sifted bleached wheat flour. These investigators pointed out that for practical purposes the field applied—1200 to 1700 v per cm at 11 megacycles per second—must be strong enough and applied long enough to give a 100 per cent lethal effect, because partial injury cannot be relied upon as a means of attaining effective control.

Sherman[26] found that high-frequency radiation heated cocoa beans so rapidly as to shell them by a sort of explosive action and that continued heating released oils. This process is recognized as having great commercial possibilities in connection with many oily seeds.

He further observed that, because of its uniform and speed heating effects, high-frequency radiation is ideally suited to dehydration and for disinfesting stored grain products.

The loss due to insect damage in stored grains and in food in general may well be prevented by sterilization which apparently may be accomplished by electronic radiation.

The future of agricultural electronics is limited only by the skill of man in putting it to work.

It is almost a breath-taking conception but the irradiation of soils by high frequency during plowing, resulting in the possible eradication of grubs, mites, insects' eggs, and disease organisms, would provide an "enemy free" environment for crops to grow in.

SUMMARY

Radiation (electronics) provides a promising means of reducing losses in agriculture from insects and disease.

Ultraviolet rays are used (a) to destroy micro-organisms, (b) to produce vitamin D and (c) to sort or select agricultural products.

Infrared rays are used (a) for dehydration of grains and forages, (b) for sexual stimulation of fowls (perhaps other animals), and (c) for therapy and general heating.

High-frequency radiations are used (a) to destroy disease and other objectionable organisms, (b) to create artificial fevers (therapeutic agent), (c) to kill insects and small animals, (d) to improve germination of seeds.

The future of electronics in agriculture will be determined by those who study it and put it to work.

REFERENCES

1 Stakman, E. C., Plant Diseases Are Shifty Enemies. American Scientist, vol. 35, no. 3, July, 1947, pp. 321-350.

(Continued on page 151)

Functional Design of a Milkhouse

By James S. Boyd
MEMBER A.S.A.E.

AGRICULTURE in the state of Michigan is probably as diversified as anywhere in the United States. Its largest industry is dairying, which ranks sixth in the production of milk in the United States. In 1945 it had a cash income of 157 million dollars worth of milk, about 23 per cent of its annual farm income.

Not all of this income would come via the milkhouse, but about 60 per cent of the annual milk supply, or 94 million dollars worth of milk, would be processed or cared for in a milkhouse. This volume of business, if carried on by industry, would surely require adequate housing for the equipment.

During the period 1942 to 1946, the demand for milk products increased, but the material available for repairs and additions to equipment was halted. Consequently the milk was handled under conditions not favorable to the production of high-quality milk. Some milkhouses were used as coverings for milk coolers, and related chores were accomplished somewhere else. The distance between the barn and milkhouse in many of these cases will vary from 50 to 200 ft, which is inconvenient.

Now that materials are becoming available, new units are being constructed. These small unsatisfactory milkhouses are being replaced. In the next few years, it is quite possible that 10,000 new milkhouses will be constructed in the state. For this reason a study of milkhouse design was inaugurated by agricultural engineers of Michigan State College.

In the state there are about twelve large cities buying milk, in addition to many smaller cities and small milk plants. These markets have certain requirements for milkhouse construction which vary somewhat, and milkhouses are all subject to inspection by state inspection officials, and it would be desirable to have some standard state-wide construction requirements.

Before attempting to suggest a plan which would satisfy all the various markets, variations in the ordinances should be brought out to determine points of agreement and disagreement between the various markets. Copies of the ordinances of the larger markets have been collected and summarized. On many points there is close agreement, but on others there are differences of opinion. These ordinances do not always tell the complete story because inspectors may read in special interpretations. There is general agreement on items of equipment and procedure, but size and location of a milkhouse have not been definite, and there are differences of opinion on these last two points.

This paper was presented at the winter meeting of the American Society of Agricultural Engineers at Chicago, Ill., December, 1947, as a contribution of the Farm Structures Division. Approved as Journal Article No. 933 (N.S.) of the Michigan Agricultural Experiment Station.

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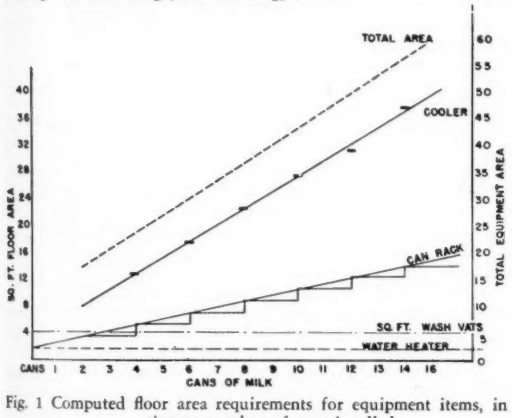


Fig. 1 Computed floor area requirements for equipment items, in relation to number of cans handled

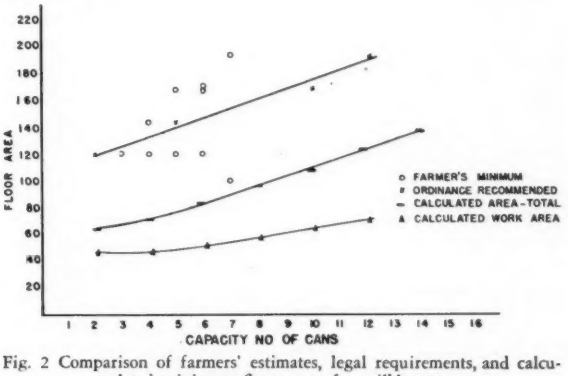
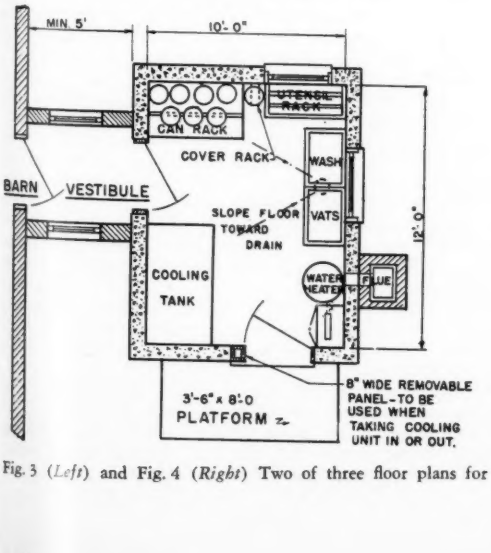


Fig. 2 Comparison of farmers' estimates, legal requirements, and calculated minimum floor areas for milkhouses



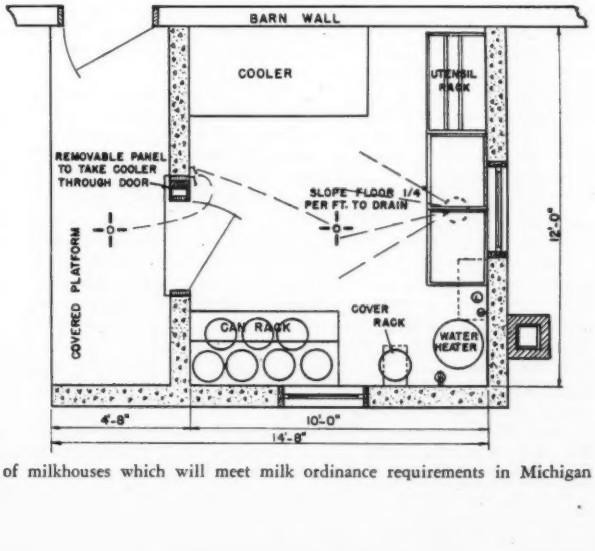


Fig. 3 (*Left*) and Fig. 4 (*Right*) Two of three floor plans for types of milkhouses which will meet milk ordinance requirements in Michigan

Fig. 5 Experimental milkhouses permitting reduction of space to determine practical minimum

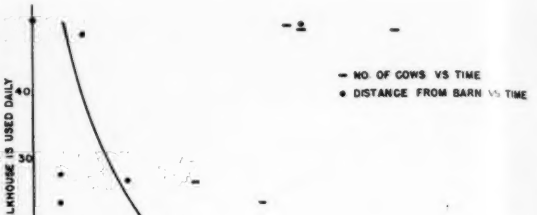

NO. OF COWS VS TIME
DISTANCE FROM BARN VS TIME
MINUTES MILKHOUSE IS USED DAILY
40
30
20
10
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180
DISTANCE FROM THE BARN IN FT.
0 5 10 15 20 25 30 35

Fig. 6 Relation between working time in milkhouse distance from barn and number of cows milked

In any milkhouse there are three functions which must be provided for. The first is a place where milk can be handled and stored in such a manner as to prevent contamination, absorption of odors, and increase of bacteria. As soon as the milk comes from the cow it should be taken to the milkhouse and strained. After the milk is strained, it should be cooled immediately, in order to produce a milk of low bacteria count. If milk can be cooled to 50 F (degrees Fahrenheit) within 60 min after it comes from the cow, rapid growth of bacteria can be prevented.

The second function is to provide some convenient place to clean the equipment used in the handling of milk. A kitchen is not the place to wash milk-handling utensils. A great deal of time can be wasted in carrying utensils between the barn and house if the washing is done in the kitchen. With a milkhouse, all the inconvenience and trouble can be taken from the house. Then, too, all the brushes, scouring powders, disinfectants, etc., will be used because they will be convenient. If a farmer takes an interest in his enterprise and uses the materials available, he can do a better job of washing and sterilizing than his wife. Prompt washing of utensils makes the task easier. One farmer spent 6 min in his milkhouse to disassemble, wash, and sterilize all of the utensils used for milking.

The third function of a milkhouse is to provide some place to store the clean utensils between milkings. Regardless of how well utensils are washed, they will get dirty if not stored in a clean place.

To provide for this, a milkhouse should include four units of equipment: a milk cooler, a can and utensil rack, two wash vats, one for washing and one for rinsing, and a water heater. In some cases other equipment is desirable but not necessary. In cold climates, where water will freeze in the milkhouse, a space heater will be necessary to make the milkhouse usable the year around. Fig. 1 shows the space requirements for these four units of equipment.

Space for a water heater and wash vats is constant within the range of two to fourteen cans of milk daily. These are the sizes of output in which we are interested. The floor area for these units was determined by measuring three standard brands. It was found that there was little variation in the dimensions.

The space for can racks and milk coolers varies with the number of cans produced. Comparisons were made on the basis of cans produced rather than the number of cows milked because of the wide variation in the production of herds. Referring to Fig. 1, the floor area for the cooler was determined by investigation of eleven different makes. This area represents the space necessary for one unit to handle the number of cans shown. If two smaller units are substituted for a large unit, this space will be somewhat larger. The space for can racks was calculated assuming that cans would be stored in pairs, one above the other.

The floor area necessary for operation was determined as follows: A working space of 2 ft wide was allowed in front of a double wash vat. Floor space for setting three pails and two milkers was allowed, plus 4 ft in front of the cooler for working space. This work area was plotted as show in Fig. 2. The total of equipment area and work area would be the calculated floor area of the milkhouse. It was found that this area was somewhat less than the farmers themselves considered a minimum. In Fig. 2, the line representing the ordinance recommendations is the average of the farmers' minimum although there is not close correlation in the farmers' suggestions. This chart would indicate that the farmers may be following the milk ordinances. This minimum size suggested by the farmers may not be a true minimum because the farmer, in a majority of cases, considered the size of his present milkhouse as a minimum. It was observed that many of the milkhouses provided convenient places for collecting trash.

Figs. 3 and 4 show two of three floor plans for types of milkhouses which will meet the requirements of the milk ordinances in the state. These plans provide sufficient room for the necessary operations, but in many installations they also provide room for trash as mentioned before. The minimum calculated size will have to be demonstrated in actual practice before it will be accepted by the milk inspectors. An experimental milkhouse has been constructed on the Michigan State College campus as shown in Fig. 5. It is larger than the minimum but is arranged so we can reduce the size to determine whether or not the minimum size is sufficient.

During visits made to various farms, it was found that many of the milkhouses were used merely to house the milk cooler. Many farmers used the milkhouse solely for this purpose and carried on the other operations either in the house or in the barn. In many cases the housewife washed the utensils.

It was found in chore route studies that the time spent in the milkhouse was inversely proportional to the distance between the barn and the milkhouse. This distance had more effect on the use made of the milkhouse than the number of cows milked, the number of cows handled, or the floor area.

Fig. 6 represents the relation between time spent in the milkhouse and distances between the barn and milkhouse. There is close correlation between these two factors. The two points farthest from the curve are special cases. One farmer had the milkhouse 90 ft from the barn, but he spent nearly 60 min per day operating a small portable cooling unit which he had to dip from can to can. Another farmer had his milkhouse connected to the barn, but he carried all the utensils to the house to be washed and used the milkhouse as storage for the equipment.

This does not indicate that farmers using their milkhouses the longest time were inefficient in the use of labor; in fact, the farmers spending the most time in the milkhouse were usually the most efficient.

From investigations thus far, it seems desirable to have the milkhouse connected directly to the barn if possible. This would have the advantage in cold climates of preventing freezing in the milkhouse. For smaller herds the size of milkhouse could be reduced and still be satisfactory.

Adapting Cribs for Corn Drying

By Leo E. Holman
MEMBER A.S.A.E.

ARTIFICIAL drying of high-moisture ear corn in farm cribs for feeding or commercial sale is a new development and only a few cribs have been built especially for artificial drying. Existing cribs can be adapted for fan drying but present individual problems of adaptation because no consideration was given to artificial drying when they were built.

This paper deals with the adaptation of cribs for drying. It is based on several years' work with farmers done cooperatively by the Division of Farm Buildings and Rural Housing, Bureau of Plant Industry, Soils and Agricultural Engineering, USDA, and the agricultural engineering departments of the Illinois, Indiana, and Iowa agricultural experiment stations.

Most cribs can be filled in the usual manner and preparation made for drying after the crib is filled. There are exceptions, especially in cases where ventilators have been installed for natural drying. These ventilators may affect the air movement when artificial drying is used, and it may be necessary to remove them, or block them, before filling the crib.

For existing cribs it is considered best to prepare them for fan drying in such a manner that they can be readapted for natural drying. Some natural air drying may be desirable even though artificial drying becomes a regular practice. With the increasing use of artificial drying, crib designs may change until the crib becomes essentially a drying bin. Field pickershellers and shelled corn drying may even tend to eliminate the farm corn crib at some future time.

The following principles concerning the adaptation of cribs for drying have been reasonably well established within the past three years:

1 A uniform flow of air through the corn is essential; air must travel equal distances through the corn in all parts of the crib to accomplish this purpose. Sections of the crib will generally have to be made airtight. Either reinforced paper or canvas are satisfactory for sealing; wood, steel, or other materials may be used to some extent.

2 It is desirable to supply air through a single duct or plenum chamber from which it is forced through the corn. Using several ducts increases the difficulty of obtaining uniform air flow.

3 The main plenum chamber should be of sufficient size to provide a cross-sectional area of one square foot for each 1,000 cu ft of air flow per minute. Smaller main ducts give high velocities causing air to move to the far end of the duct, resulting in faster drying in that section than near the fan. Shelling trenches or other ducts with small cross-sectional areas are not recommended as main ducts because of the resulting high velocities.

4 Ventilators should not be placed in cribs prior to or during filling unless they will assist in providing uniform air flow through the corn. Improperly installed ventilators may do more harm than good by making it impossible to get even distribution of air.

5 Ear corn should be husked as clean as possible and shattered or shelled corn removed before cribbing. Frequent moving of the elevator spout assists in getting even distribution of husks, silks, dirt, and broken or shattered shelled corn. The air will by-pass areas where this debris accumulates.

A number of examples of crib preparation and adaptations as used in the corn belt are discussed and illustrated in this paper.

Double Crib with Overhead Bins (Fig. 1). This common crib type is readily adapted for fan drying. The driveway is satisfactory as a main duct, because of its large cross section. Both ends are sealed and the fan mounted at one end. Air blown into the driveway passes through the corn to the outer walls or to the upper surface of the corn.

To secure uniform air movement through the corn, end walls of the crib are sealed, or, as an alternative, crib walls in the driveway are sealed, beginning at the end and extending back a distance about equal to two-thirds the width of the crib. Sealing the ends gives the best air distribution, although this requires more material. Generally, the ends can be sealed permanently without seriously affecting natural ventilation.

The depth of corn above the level of the bin floor should be about equal to the width of the crib with allowance made for settling as the corn dries, especially in deep cribs. Where height of settled corn above the bin floor is less than crib width, the upper part of the driveway is covered. Where height of corn is greater, bin walls are slatted to equalize the air path through the corn.

Seven cribs of this type have been observed during the past two years and two cribs adapted in 1946 were studied again in 1947. In these two cribs the driveway walls were sealed in 1946. Although the drying in the corner areas was sufficient to prevent spoilage, the owners believed that sealing the ends would give better results, so this change was made in 1947.

This paper was presented at the winter meeting of the American Society of Agricultural Engineers at Chicago, Ill., December, 1947, as a contribution of the Farm Structures and Rural Electric Divisions.

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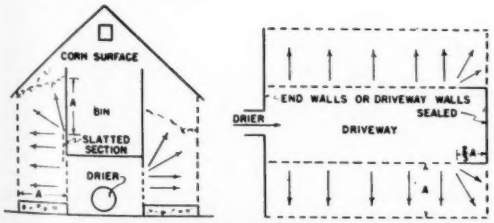

Fig. 1 Double cribs with overhead bins can be readily adapted for forced drying. The driveway when used for the main duct provides ample cross-sectional area for desirable low air velocities. Both ends are sealed and the drier installed in one end. Air blown into driveway moves through cribs as indicated by arrows. Equal distances for air travel to corn surfaces are important; therefore, distances *A* should be about equal after allowing for settling

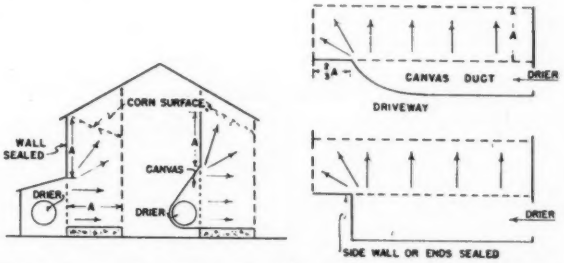

Fig. 2 Double crib without overhead bins. Driveway can be used as a main duct by sealing over the upper part of driveway. For drying one crib at a time a duct along the outside or inside wall is generally easier to build. Air blown into the duct moves through the crib as indicated by arrows. Distances *A* should be equal except for allowance made for settling. Better drying can be obtained by giving attention to contour of corn surface

Tests in these cribs, as well as in others, show that sealing the end walls is desirable from the standpoint of uniform drying.

Observations have shown the importance of depth of corn and also the contour of the upper corn surface. Cases have been reported where the corn at the top of double cribs with overhead bins has not dried at all, while at the same time corn in the lower part of the crib has been dried more than necessary. The depth of corn above the bin floor was too great for uniform air flow.

In similar cribs where the corn surface has been level, corn near the surface next to the overhead bin wall dried at about the same rate as corn in the lower part near the outer wall. At the same time, surface corn near the outside wall contained 2 per cent more moisture. Drying has been much more uniform where the surface has been given a slope similar to that shown in Fig. 1.

Farmers having double cribs may prefer to dry only one crib at a time. In some instances, one driveway wall was sealed and all of the air forced through one crib; in other cases a canvas loosely covering a crib wall was used as the main duct (Fig. 2). This method is simpler and better than the method of using the driveway in drying one crib where overhead bin floors are not tight, or where it is difficult to seal driveway walls immediately below the bins. Duct tightness is important to prevent air leakage; the canvas should be as airtight as possible.

In some double cribs it was found impractical to use the driveway as a main duct because of an inside elevator that is needed to handle corn into and out of the crib. Then a duct built alongside or within the crib was suggested. The main duct along the side of the crib is preferable to the duct through the center, not only to provide uniform air flow through the corn but also to avoid reducing the storage capacity.

Double Crib Without Overhead Bins. The driveway of this crib type is also satisfactory as a main duct. As there are no overhead bins, it is necessary to seal over the driveway to prevent air leakage. End walls or driveway walls are sealed as in cribs with overhead bins.

Where one crib is dried at a time it is generally easier to use a duct built alongside the outer or inner wall. A crib was studied with duct built along the outer wall. End walls were sealed, but the wall at the ends of the duct was covered to prevent air "short-circuiting" across the corners. Drying was satisfactory, though not entirely uniform. The main duct was not high enough to give adequate air flow through the corn at the top of the crib. The corn surface was not sloped as shown in Fig. 2, so drying there was not uniform. The duct extended too near the crib ends resulting in faster drying there.

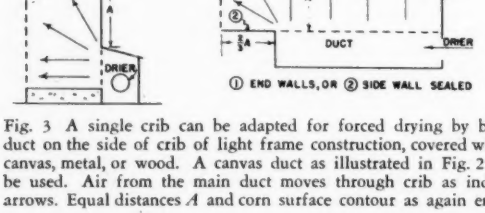

Fig. 3 A single crib can be adapted for forced drying by building a duct on the side of crib of light frame construction, covered with paper, canvas, metal, or wood. A canvas duct as illustrated in Fig. 2 may also be used. Air from the main duct moves through crib as indicated by arrows. Equal distances *A* and corn surface contour as again emphasized

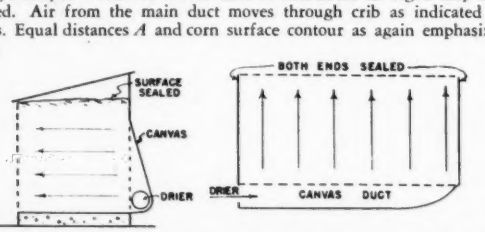

Fig. 4 Single crib where crib width and corn depth were both 12 ft. Crib was adapted for forced air drying by sealing both ends, covering the surface, and attaching canvas to the back wall to form the main duct. Air blown into the duct moved horizontally through the entire crib as indicated by arrows

Single Cribs. These can be adapted for artificial drying by constructing the main duct along the side or through the center of the crib. Outside ducts of canvas, paper, or wood as illustrated in Fig. 3 have been used with good results. With this method, also, end walls or the side walls, at the ends of the main duct are sealed to insure uniform air flow.

Observations were made in an unusually wide single crib adapted for fan drying. As the crib width and corn depth were both about 12 ft, both ends were sealed; the corn surface was covered and a canvas duct covering one entire wall was used (Fig. 4). Air was then forced horizontally through the entire crib. Air distribution was quite uniform through the entire crib.

Ducts or ventilators installed through the center of cribs should be large enough to provide low velocities and uniform air distribution. They can be used for natural and forced drying if installed properly (Fig. 5). Where the ventilator is open at both ends, it assists natural air drying by dividing the crib. The ventilator is made ready to serve as the main duct for artificial drying by closing one end and connecting the drier to the other end. Air is forced out through both sides of the crib. This system is more satisfactory in cribs 8 ft or wider because of the space required.

One crib studied was 16 ft wide and had a "dragway" or ventilator 20 in wide built through the crib center. The dragway ends were sealed and the drier installed in one end. This type of crib is easy to adapt as little material is required for sealing. With uniform corn depths over the top of the ventilator, air flow will be rather uniform. The effect of wind on drying rates was first noted in this crib. Drying was uniform during part of the drying period, but, after several days of wind from one direction, it was found that drying had been retarded on the windward side.

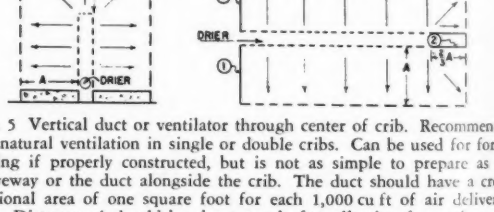

Fig. 5 Vertical duct or ventilator through center of crib. Recommended for natural ventilation in single or double cribs. Can be used for forced drying if properly constructed, but is not as simple to prepare as the driveway or the duct alongside the crib. The duct should have a cross-sectional area of one square foot for each 1,000 cu ft of air delivered. Distances *A* should be about equal after allowing for setting

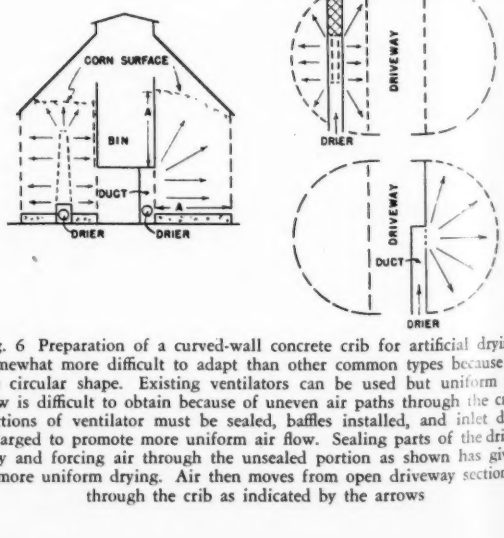

Fig. 6 Preparation of a curved-wall concrete crib for artificial drying. Somewhat more difficult to adapt than other common types because of the circular shape. Existing ventilators can be used but uniform air flow is difficult to obtain because of uneven air paths through the crib. Sections of ventilator must be sealed, baffles installed, and inlet duct enlarged to promote more uniform air flow. Sealing parts of the driveway and forcing air through the unsealed portion as shown has given more uniform drying. Air then moves from open driveway section through the crib as indicated by the arrows

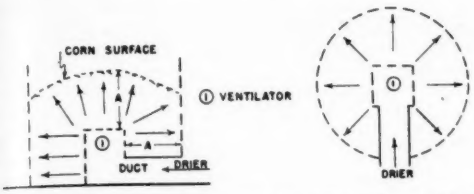

Fig. 7 A temporary round wire or snow fence crib can be readily adapted for forced drying by using an existing ventilator or by installing one as illustrated. Round ventilators are preferred, but are more difficult to construct if they cannot be purchased. Duct and ventilator should be of sufficient size for proper velocities

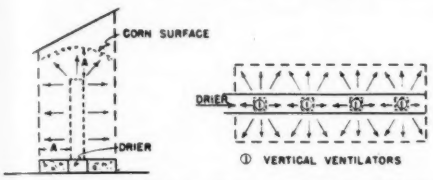

Fig. 8 Preparation of crib for artificial drying where shelling trench and vertical ventilators are used. Most shelling trenches or ducts of similar size are too small to provide sufficient air volume at velocities of 1,000 fpm or less. Dead-air spots causing uneven drying can be expected between the vertical ventilators

Curved-Wall Concrete Cribs. This type of crib is more difficult to adapt for artificial drying than other common types. Uniform air flow is hard to obtain because of the crib shape. Limited tests indicate that good air distribution can be obtained by sealing parts of the driveway walls and forcing air through the unsealed section (Fig. 6). Air then moves through the corn in a fan-shaped pattern. Air flow will be satisfactory in the upper part if attention is given to corn depths and surface contours.

Ventilators customarily found in this type of crib have been used in artificial drying with limited success. Some modifications are generally needed to provide proper air velocity and uniform air flow. Where the shelling trench is used as the main duct, velocities are generally too high and drying is more rapid in the far end of the ventilator. Considerable attention is required to get uniform air flow through corn above the ventilator. Because of uneven crib sections, the ventilator requires sealing in certain sections to obtain better air flow.

Temporary Cribs. Temporary circular cribs of wire or snow fencing are easily adapted for forced air drying (Fig. 7). A ventilator at least 2 ft wide is placed at the crib center with an air duct leading from the crib wall into the ventilator. The depth of corn over the ventilator is important in obtaining good air distribution. Some farmers have indicated a preference for this type of crib for artificial drying over the use of a regular crib.

Crib with Tight Wall and Perforated Floor. Some cribs have been adapted for forced air drying by sealing all walls and providing a perforated floor above the permanent floor. The space between the floors serves as a plenum chamber. This method provides for uniform distribution as all air passes through equal thicknesses of corn. The cost of adaptation is relatively high and the crib becomes essentially a bin drier.

The shelling trench, or a duct of similar size, has been used as the main duct in a number of cribs. Vertical ventilators are set over the ducts to distribute the air through the corn (Fig. 8). Such systems are generally not too satisfactory. First, small main ducts cause velocities above 1,000 fpm in most installations. Uneven drying results with faster drying at the outer end of the duct and slower drying near the fan. Second, it is difficult to obtain uniform drying when using a number of vertical ventilators. Dead-air spots are likely to occur midway between each ventilator. Wet corn can be expected in these spots unless the ventilators are less than 2 ft apart. Preparation of the crib is rather difficult and considerable storage space is lost.

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(Continued from page 146)

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Fence Post Preservation

By George H. Dunkelberg
MEMBER A.S.A.E.

THIS paper deals with the preservative treatment of fence posts of longleaf and shortleaf southern yellow pine with water-soluble salts by the "trough" or sap-stream displacement method, and is based on an investigation conducted at the South Carolina Agricultural Experiment Station.

The trough method of treatment, using green, freshly cut posts, is one in which the sap in the wood is displaced by a toxic solution of water-soluble salts. The post, with bark intact, is placed in a vertical position, with the butt end in the solution and the salts move slowly upward. After sufficient absorption has taken place, the post is reversed and the top end placed in the solution. After treatment is complete, the posts are stacked in a vertical position, butt end up, and allowed to airdry. During this curing period, the solution moves by gravity throughout the post.

Investigations by the South Carolina Station have been limited to two of the more common water-soluble preservatives — copper sulphate and zinc chloride, the latter both plain and chromated.

Longleaf and shortleaf pine were chosen because of their widespread availability, relatively fast growth, high percentage of sapwood, and short life when untreated. Subsequent investigations by other experiment stations have shown that many other species of both hardwoods and softwoods may be similarly treated.

The South is not as large a user of fence posts as some other regions of the country, but since livestock is on the increase many millions of posts are used annually. Concrete, steel, and pressure-treated wood posts are known to have a long life when properly handled, but the relatively high first cost of these posts prohibits their use by many farmers in the low income bracket. Because much of the area of the South is forested, native posts are readily available, but only a few species are of a durable variety, and the supply of these is rapidly diminishing. Nondurable species are very short-lived because of the activity of both decay and termites.

The trough method of treatment shows promise for use by farmers as the process is very simple, little equipment is required, peeling of the posts is unnecessary, and the cost of the preservative is low.

The purpose of the investigation undertaken was threefold, namely, (1) to determine the service life of posts treated by this method, (2) to determine the procedure to be followed in treating to insure adequate protection against decay and termites, yet one which would be simple enough to be easily followed, and (3) to determine the cost per post per year, including that of replacement, and the comparison of this cost with that of posts treated by other standard methods.

To determine the service life as soon as possible, test plots were established early in the investigation, even though the exact procedure to be followed in treating was not known. The first test plots established are now seven years old.

Absorption studies were run concurrently with the test plots, to furnish more detailed information of the effect on the retention of dry salt per cubic foot of wood of such things as time of cutting and treating, size and density of posts, concentration of solution, and methods of handling the posts during the treating process.

Results of the shortleaf pine test plots are shown in Fig. 1. In addition to the determination of the average service life of treated posts, these test plots were set up to include a study of the effects of seasoning after treatment. Fig. 1 shows that all check (untreated) posts had failed at the time of the last examination. As a matter of fact, none of the check posts were capable of supporting a fence at the 1945 inspection, five years after being set. On the average, 53 per cent of the zinc chloride treated posts show no damage by either termites or decay. There is also a definite indication that a longer period of air drying is advantageous when this salt is used as a preservative. Fifty (50) per cent of the copper sulphate treated posts were in good condition at the 1947 inspection. With this salt, seasoning after treatment apparently has little effect on the service life of the post. Inspection of the test plots showed that most of the damage which occurs to treated posts is caused by decay, while termites are usually the major factor in the failure of untreated posts.

The condition of the longleaf pine test posts at the 1947 inspection is shown in Fig. 2. Here all but one of the check posts had failed at the end of five years. Termites were again a major factor. At the end of seven years zinc chloride treated posts are all classed as good; that is, they show no effect of damage by either termites or decay. Sixty (60) per cent of the copper sulphate treated posts are good, and again the failures show no termite damage, but were caused by decay. It is interesting to note that a bad grass fire in 1944 damaged 50 per cent of the copper sulphate treated posts, although none of the zinc chloride treated posts were injured. This indicates that a sufficient amount of zinc chloride is present in posts treated by this method to render them resistant to fire.

Copper sulphate was one of the first preservatives used in this investigation and was known to be extremely corrosive to fencing material. For that reason an experiment was set up in an attempt to find a corrosion-resistant staple or wire. Fig. 3 shows the corrosion of staples used as fasteners on

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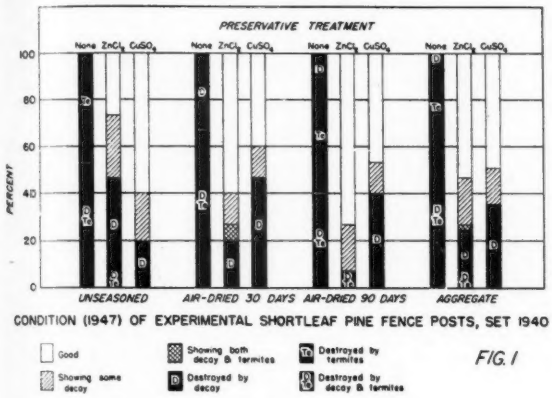
Left: Clipping the ends of the green pine posts prior to treating. This removes the accumulation of gum which tends to seal the ends of the posts • *Center:* Mixing the post-treating solution in a wooden container. Two pounds of zinc chloride per gallon of water is the proper ratio for pine posts • *Right:* Adding the solution to the container after the ends have been clipped. About two quarts of solution will treat the average size post

shortleaf pine treated with copper sulphate and with zinc chloride. The chart shows that zinc chloride treated posts are only slightly more corrosive than untreated posts. Inspections showed that the corrosion was more rapid at first on zinc chloride treated posts, but slowed after a few months, and has since progressed at about the same rate as untreated posts. On the other hand, the chart shows that copper sulphate is severely corrosive. Over 60 per cent of the staples in the test have failed, and none of the staples in the test showed any significant resistance to corrosion. As a result, copper sulphate as a preservative is not recommended in the treatment of posts where steel wire and staples are to be used. It was also noticed that corrosion was quite severe on both woven and barbed wire which was fastened to copper sulphate treated posts. The staples always failed first, but corrosion of the wires followed closely and there are many failures evident in the test wire.

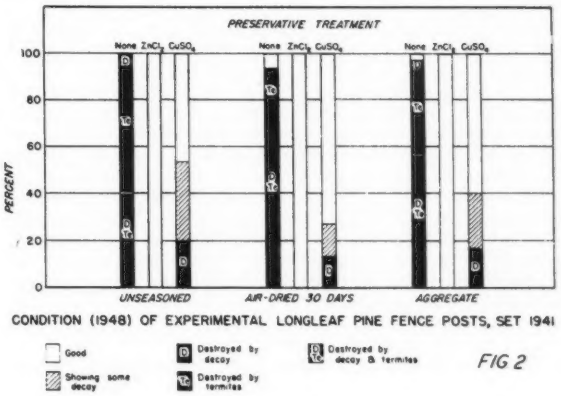
It was reasonable to expect copper sulphate corrosion might be less severe if the posts were properly seasoned after treatment. Fig. 4 shows the corrosion of polished steel staples for different seasoning periods. While the polished staples were damaged more severely than any of the zinc-coated staples, the effect of seasoning is representative for all. There is no significant effect in these tests due to seasoning.

Absorption studies were started in 1941 and 1942 and a large number of quantitative chemical analyses were made on copper sulphate treated posts to determine the distribution of salts within the posts under various methods of handling. Fig. 5 shows that with a seven-day butt treatment, where the post was cured with the butt down, there is a high concentration of salts at the lower end of the posts, which runs out rapidly toward the top end. However, there is a trace of salt throughout the entire length of the post. Posts which were given a seven-day butt treatment *(Continued on page 156)*



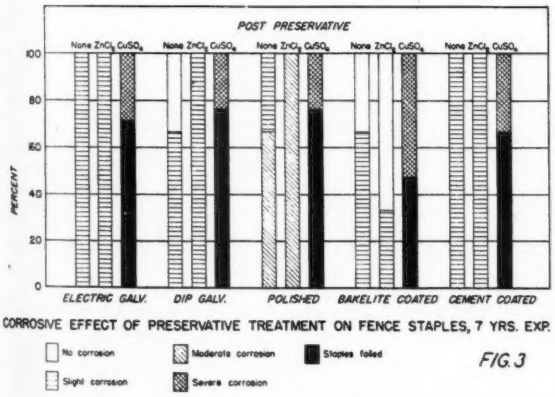
CONDITION (1947) OF EXPERIMENTAL SHORTLEAF PINE FENCE POSTS, SET 1940

FIG. 1



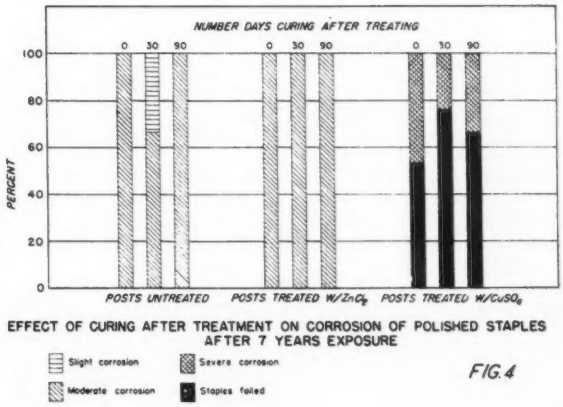
CONDITION (1948) OF EXPERIMENTAL LONGLEAF PINE FENCE POSTS, SET 1941

FIG. 2



CORROSIVE EFFECT OF PRESERVATIVE TREATMENT ON FENCE STAPLES, 7 YRS. EXP.

FIG. 3



EFFECT OF CURING AFTER TREATMENT ON CORROSION OF POLISHED STAPLES AFTER 7 YEARS EXPOSURE

FIG. 4

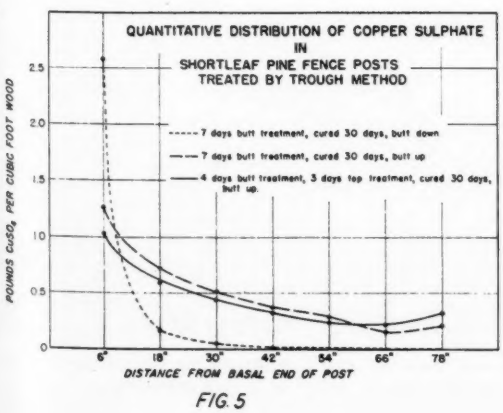
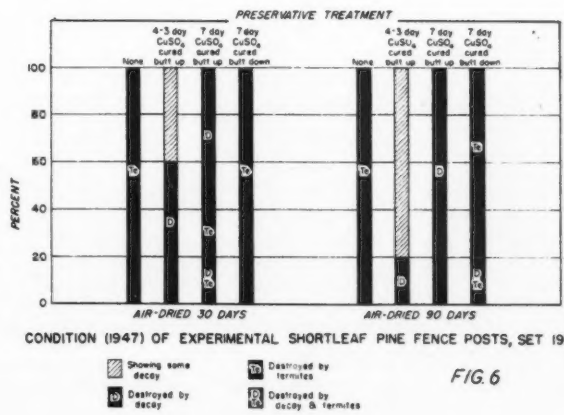

QUANTITATIVE DISTRIBUTION OF COPPER SULPHATE IN SHORTLEAF PINE FENCE POSTS TREATED BY TROUGH METHOD
7 days butt treatment, cured 30 days, butt down
7 days butt treatment, cured 30 days, butt up
4 days butt treatment, 3 days top treatment, cured 30 days, butt up.
POUNDS CuSO4 PER CUBIC FOOT WOOD
DISTANCE FROM BASAL END OF POST
6" 18" 30" 42" 54" 66" 78"

FIG. 5


PRESERVATIVE TREATMENT
None
4-3 day CuSO4 cured butt up
7 day CuSO4 cured butt up
7 day CuSO4 cured butt down
4-3 day CuSO4 cured butt up
7 day CuSO4 cured butt up
7 day CuSO4 cured butt down
PERCENT
AIR-DRIED 30 DAYS
AIR-DRIED 90 DAYS
Showing some decay
Destroyed by termites
Destroyed by decay
Destroyed by decay & termites

CONDITION (1947) OF EXPERIMENTAL SHORTLEAF PINE FENCE POSTS, SET 1942

FIG. 6

The Effect of Structural Condition on Soil Detachment by Raindrop Action

By Russell Woodburn
MEMBER A.S.A.E.

THE energy content of raindrops and their destructive effect on soil has been noted by a number of investigators. Borst and Woodburn[1]* state, "Further evidence of the potent effect of drop impact is disclosed when supported mulch was quickly removed during a run. Soil concentration in the runoff increased sixfold." This subject has been given wide study by Ellison[2] who defines soil erosion as follows: "Soil erosion is a process of detachment and transportation of loose materials by erosive agents."

Ellison[3] has further postulated and defined the sequential steps of detachment and transportation in a recent series of papers.

It is not within the scope of this study to investigate the transportive process. The objective of this paper is to develop relationships between applied raindrop energy and resultant soil splash for several Mississippi soils in both natural structural condition and pulverized.

Extensive preliminary studies were made with cups of pulverized soil exposed to gradually increasing increments of natural rainfall. Difficulties of servicing such an installation in order to break natural rains into increments and to secure desired number of data led to the decision of using artificial rainfall for this study.

A small rain simulator was designed and installed in the attic of the soil conservation plot service building. The design of the rainfall applicator is essentially that developed in the hydraulic laboratory of the National Bureau of Standards by the Soil Conservation Service in 1936. This device employed water direct from the campus mains piped to a small multiple-orifice nozzle of which the jets impinge upon a piece of window screen. The fine spray dropped from the screen upon a cloth through which was threaded a large number of small pieces of darning wool. The water followed the wool threads and formed drops at the end. A schematic drawing of the device is shown in Fig. 1.

In starting a test with the wool threads dry it was found that water ran down the threads rather than saturating them properly. It was, therefore, necessary to treat the threads with a wetting agent, such as Vatsol K, just prior to a run. A mercury U tube manometer was attached to the water line just before it entered the nozzle. Pressure was adjusted to such a manometer reading that the nozzle delivered the desired quantity of water, namely, ½ gal in 2 min 35 sec.

The 5.1-mm drops fell 12 ft to the soil cups or core cylinders below, which were placed upon a rotating table. This table turned at about 22 rpm and served to take all samples through the same raindrop pattern in order to offset any variation of rain over the surface of the table. The rain intensity received in the cups was about 12 in per hr.

For a test with the soil in a natural structural condition cores were taken in the field in cylinders of 3½-in diameter and 2-in depth using equipment designed by Woodburn and Jones[4]. Twenty samples were taken of which four were reserved for moisture samples. The remaining 16 samples were subjected to raindrop action in general as follows:

4 cores received 10 minutes rain
4 cores received 20 minutes rain
4 cores received 40 minutes rain
4 cores received 60 minutes rain

The amount splashed was computed from the dry weight before the test as determined from field weight and moisture percentage and the ovendry weight after the test.

The tests on the pulverized soil were conducted as follows: The soil was air-dried then pulverized on a concrete floor by rolling with a heavy pipe. It was then sieved through a 1-mm N.B.S. sieve and oven-dried. Twelve cups 3½ in in diameter by 2 in deep were filled with the oven-dried material and it was then thoroughly wet by capillary action through small holes in the bottom of the cups. Three cups of the pulverized saturated soil were then subjected to 10 min of raindrop action followed by the remainder in sets of three for durations of 20, 40, and 60 min.

This paper was presented at the winter meeting of the American Society of Agricultural Engineers at Chicago, Ill., December, 1947, as a contribution of the Soil and Water Division. This paper is also a contribution of the Division of Research, Soil Conservation Service, U. S. Department of Agriculture, and the agricultural engineering department, Mississippi Agricultural Experiment Station, published with the approval of the Director of the Mississippi Station as paper No. 157 New Series.

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*Superscript numbers refer to appended references.

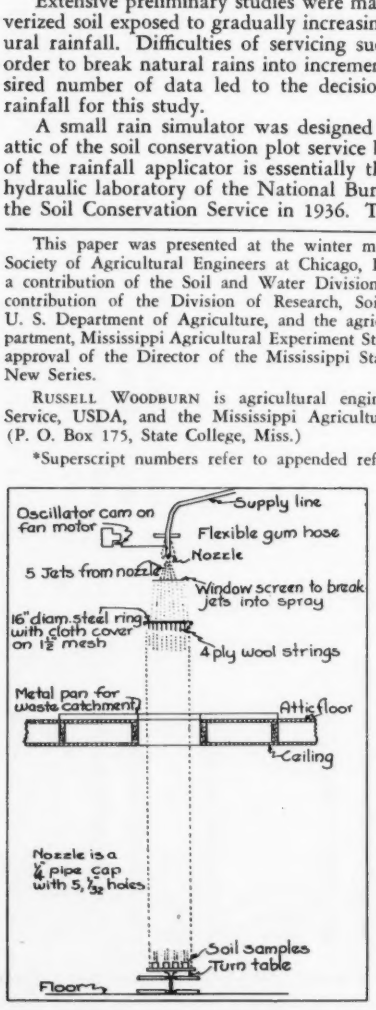

Fig. 1 Schematic drawing of raindrop applicator

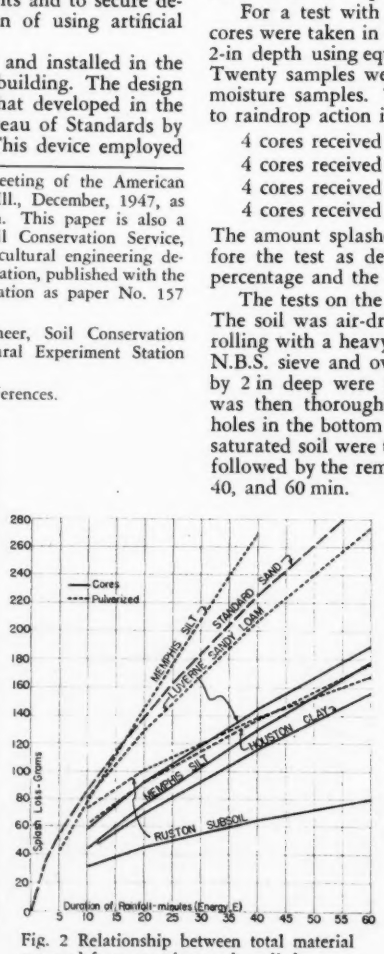

Fig. 2 Relationship between total material removed from container and applied energy

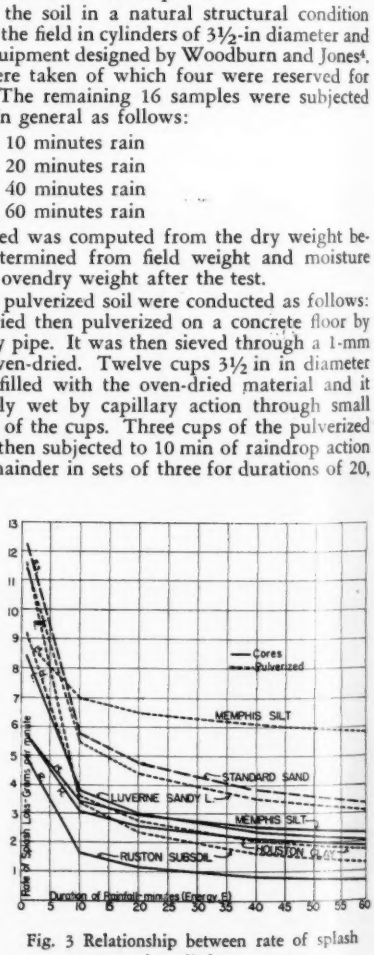

Fig. 3 Relationship between rate of splash and applied energy

TABLE 1. SPLASH LOSS FROM CONTAINERS OF SOIL AFTER VARYING APPLICATIONS OF RAINDROP ENERGY
Weight of Soil Removed in Grams for Each Test Used in Analysis

Duration of energy application, min	American graded sand	Luverne sandy loam		Memphis silt		Ruston subsoil		Houston clay	
		Pulv.	Cores	Pulv.	Cores	Pulv.	Cores	Pulv.	Cores
2.5	36 33 35 34 30 33 33 28 32								
5.0	58 59 58 63 51 53								
10*	90 94 91 87 89 86	80 74 79	46 62 71 66	80 78 80	53 53 34 46	73 70 72	39 24 25 40	62 58 58	38 39 46 54
15	104 111 114 131 116 127 105 103 115								
20	138 139 130 144 123 141	135 135 135	121 81 61 86	158 154 155	74 74 42 93	107 99 100	49 46 25 64	99 103 100	70 84 77 73
25	173 149 158 148 156								
30	171 170 220 189 207			240 236 232					
40		205 214 214	179 162 135 127	261 260 250	152 144 151 128	140 144 150	76 99 62 65	132 133 149	132 116 111 120
60		264 262 264	178 156 214 220		176 177 159	151 163 173	70 49 102 76	165 178 171	136 157 164 155

*10 min. except Houston Clay pulverized which was 10.5 min and values 46 and 54 g on cores which was 12 min.

Properties of the soils are given in Table 3.

Weights of material splashed out of the cans or cylinders for all tests are given in Table 1.

Soil splash was plotted against time of rain application (used synonomously with energy) for all runs. It was observed that an exponential relationship would fit the data for most tests quite well. Accordingly a curve of the type $S=KE^P$ was fitted by least squares to each set of data where S is soil splash in grams, K is a constant depending upon the soil, and E is applied energy expressed in minutes of rainfall. The power P and the constant K were determined analytically by the method of least squares from the data. It was considered that at zero energy application there would be zero soil removed from the cup. The first raindrop or the first increment of applied energy appeared to remove some soil. Therefore, the selected function appeared to be suitable for expressing the relationship between the variables.

Lack of space precludes showing the plotted position of all points for all tests. However, the calculated curves showing soil splash plotted against time or energy are shown in Fig. 2. The equations for these curves are shown in Table 2. It may be seen (Table 1) that there was a high degree of uniformity in the data for the pulverized soil. The index of correlation was generally of the order of magnitude of 0.98 for these curves.

There was considerably more variation in the data for the cores. The index of correlation for the Ruston subsoil cores was 0.75. The curve fit was much better on the Houston cores with 0.97.

The amount of material splashed from the containers of different soils at the end of various periods of application of raindrop energy varied over rather wide limits. A core of

TABLE 2. COMPUTED RELATIONSHIP BETWEEN APPLIED ENERGY (E) AND WEIGHT OF SPLASHED MATERIAL (S)

	Pulverized material	Natural structure cores	Rate of splash (grams per min) when E=1	
			Pulverized material	Cores
Standard sand	$S=17.87E^{0.69}$ $DS/DE=12.25E^{-0.31}$		12.25 g per min	
Luverne sandy loam	$S=16.72E^{0.68}$ $DS/DE=11.41E^{-0.32}$	$S=12.86E^{0.66}$ $DS/DE=8.43E^{-0.34}$	11.41	8.43
Memphis silt	$S=9.89E^{0.90}$ $DS/DE=8.87E^{-0.10}$	$S=7.34E^{0.78}$ $DS/DE=5.72E^{-0.22}$	8.87	5.72
Ruston subsoil	$S=24.92E^{0.47}$ $DS/DE=11.6E^{-0.53}$	$S=9.54E^{0.52}$ $DS/DE=4.95E^{-0.48}$	11.60	4.95
Houston clay	$S=15.46E^{0.59}$ $DS/DE=9.2E^{-0.41}$	$S=7.83E^{0.73}$ $DS/DE=5.72E^{-0.27}$	9.20	5.72

DS/DE is the first derivative of S with respect to E and is the *rate* of splash with respect to applied energy or elapsed time.

Fig. 4 *(Left)* Soil pedestals formed under clumps of vegetation on Luverne Sandy loam • Fig. 5 *(Right)* Close-up of pedestals under grass and a pine tree on Luverne Sandy loam

TABLE 3. MECHANICAL ANALYSIS OF STANDARD SAND AND NATURAL SOILS USED IN TESTS

Material description	Sand, per cent	Silt, per cent	Clay, per cent	Weight of dry material in a 2 in deep by 3½ in diameter cup or core cylinder
Standard sand—a fine white silica sand—American Graded Sand Co., Chicago, Ill.	Passing 60-mesh standard sieve Retained on 70-mesh standard sieve			480 g
Luverne sandy loam—topsoil, 0–2 in deep—pine woods site—a few fine roots	60	33	7	Pulverized – 500 g Cores – 470 g
Memphis silt—parent silt material 10 ft below surface	5	85	10	Pulverized – 365 g Cores – 390 g
Ruston subsoil—12 in deep—very firm	24	43	33	Pulverized – 405 g Cores – 430 g
Houston clay—0–2 in (0–½ in loose and fragmented)	32	24	44	Pulverized – 350 g Cores – 390 g

Ruston subsoil, for instance, at 40 min had lost only 80 g while pulverized Memphis silt had lost 269.

There was considerable variation between the losses from different soils and, as was expected, wide differences between cores of undisturbed soil and the same material pulverized.

These data strikingly suggest the necessity of a range of values for the active variable when soils are being compared. A comparison of the splash susceptibility of two soils at 10 min, for example, results in an entirely different ratio than at 60 min. This renders necessary an energy-splash curve if we wish to compare splash-resisting properties of two soils. When a study is made of the equations of the curves just discussed, it is apparent that the varied positions of the curves has been brought about by a rather complex interaction of coefficients and exponents. This was rather disappointing as it was hoped that a similarity of exponents would permit comparison on the basis of coefficients, or vice versa.

In an attempt to secure a further lead on inherent differences in soils, each of the soil loss curves was differentiated. The ds/de equations are shown in Table 2 and are plotted in Fig. 3. The first derivative of a mass soil loss curve represents rate of soil loss in grams per minute at any desired value of the time or energy variable (E).

The reduction in rate of soil splash as the energy application continues may be considered as due to two factors for a clean cohesionless nearly uniform particle size material like a standard sand. These are compaction by raindrop impact and the effect of the container side rising above the surface of the material as the run continues. It was first thought that the effect of the can on the standard sand splash rate could be evaluated by the difference in ordinates on the sand curve at various times and the ordinate near the beginning of the run, say, at E=one minute. If this were true, the can effect could be computed as a function of time, and this function could be applied to each of the soil runs. Further analysis disclosed that this procedure would lead to highly erroneous values especially for the cores. It was then concluded that the drop down in the sand rate curve was the result of both compaction and surface lowering relative to the top of the can side. In case of the soils the two factors mentioned operate as well as pore sealing and other secondary compaction phenomena.

Certain facts are, however, apparent from a study of the rate curves. Pulverized Luverne sandy loam is quite similar to the standard graded sand and maintains a high splash rate for 60 min. Memphis silt in a pulverized condition suffers splash displacement at an excessive rate for the entire test.

Natural cores of Memphis silt and Luverne sandy loam were more susceptible to splash even after 60 min than pulverized Ruston subsoil or Houston clay. There was little difference between Houston clay pulverized and the cores. This was expected as there was considerable loose material on the upper part of the Houston cores. Ruston subsoil, which was a very tough compacted material, was the least vulnerable to splash loss of any soil tested.

The soil splash rate was generally far lower on the undisturbed cores than for the pulverized material.

Observations in the field verified the very high splash susceptibility of Luverne sandy loam.

In Fig. 4 an over-all view of a badly eroded Luverne area is shown. Soil pedestals 6 to 12 in high may be noted where the top and roots of kudzu plants and a little grass have given surface protection and reinforced soil resistance to erosive action by raindrops. Some results of runoff erosion are also apparent in the photograph.

The close-up of two pedestals in Fig. 5 shows the extreme erosion which has taken place. The sloping sides of the pedestal under the pine tree are probably significant of the time relation between protected area and tree growth.

Protection of such soils by plantings of this type cannot be entirely successful. The area between crowns must be mulched or otherwise protected.

SUMMARY AND CONCLUSION

Several soils in both natural and pulverized condition were subjected to raindrop energy and the amount of splashed material was determined.

There was a wide variation in the resistance to raindrop impact among the five materials tested.

Among the pulverized materials a tough Ruston subsoil was most resistant and Memphis silt was most vulnerable. This was, also, generally true of the cores of the same materials.

Pulverizing the soil greatly reduced its resistance to removal by raindrop action.

It may be broadly concluded that splash susceptibility is an important physical property of any soil. Different soils have different splash characteristics dependent upon particle size distribution and many other factors.

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Fence Post Preservation

(Continued from page 153)

and cured with the butt up show a high concentration in the butt, and a rather good concentration throughout the remainder of the post, except it is somewhat low at the top end. The most desirable concentration throughout the entire post was secured by treating the butt for four days and the top for three days, then curing with the butt up. This results in heavy concentration in both ends and a good concentration throughout the central portion of the post.

Posts treated similarly to those which were analyzed, were set in test plots in 1942. Fig. 6 shows the condition of those posts five years later. It is significant that the treatment on both the butt and top ends results in a longer life than the treatment on the lower end alone. Posts which were cured butt down failed very early and those which were treated for seven days and then cured butt up failed almost entirely on the top, which was probably due to an insufficient concentration of salts in that area.

Economic studies on this method of treatment are not yet complete as the average service life is not known. However, the labor requirements for treating are very low, and the cost of the preservatives is low, averaging from six to ten cents per pound. One pound will treat an average size post. It is felt that this method of treating should have a place in supplementing other preservative treatments which produce posts with a longer service life, but which cost a great deal more.

Irrigation Requirements of South Carolina Soils

By T. C. Peele, O. W. Beale, and F. F. Lesesne

WHEN designing an irrigation system for a given soil type, the two most important things the engineer needs to know about the soil are the rate at which it can absorb water and the quantity of water that it can retain in a form available for plant use. If the soil will absorb water at a maximum rate of 0.3 iph (inches per hour) under the method of irrigation that is to be used, it is evident that a system designed to supply water at a rate greatly exceeding this value is wasteful. Likewise, if the soil can retain only 2.0 in of water in the zone that is to be wetted, the irrigation system should be designed to supply this quantity of water.

Infiltration Rates of Soils. The infiltration rate of soils during simulated rainfall gives a useful estimate of the rate at which they may be expected to absorb water during sprinkler irrigation. This infiltration rate depends on the soil properties and on the amount of energy exerted on the surface of the soil by the rainfall. The energy exerted on the soil surface is influenced by the rainfall characteristics and by the amount of protection of the soil surface by plant cover. The infiltration rate of most soils receiving sprinkler irrigation is influenced to a large extent by what happens to the surface ¼ in of soil. If the surface becomes puddled quickly and forms a relatively impermeable layer, the soil will have a low infiltration rate. If the soil has physical characteristics which make it relatively resistant to puddling during rainfall, or if the surface is protected by plant cover, the soil will maintain a high infiltration rate for a considerable period of time.

TABLE 1. INFILTRATION OF FOUR SOUTH CAROLINA SOILS WITH THE SOILS LOOSE AND DRY AT BEGINNING OF THE TEST — DRY RUN

Soil type	Cumulative infiltration, in 15 min	30 min	45 min	60 min	Infiltration rate at the end of 60-min rainfall, iph
Madison clay loam	.60	.79	.94	1.05	.42
Cecil clay loam	.77	1.08	1.31	1.50	.76
Cecil sandy loam	.40	.53	.63	.69	.25
Durham sandy loam	.42	.61	.78	.93	.60

The infiltration rates of four South Carolina soil types, with the soils cultivated and free of plant growth, were measured by Peele, Latham, and Beale[1*]. Simulated rainfall was applied with a type F artificial rainfall apparatus on an area 6x24 ft in size and the infiltration during each 5-min period up to 60 min was recorded. A test was made with the soil loose and dry, called the dry run, and the following day a similar test was made with the soil wet and compact, called the wet run. The quantities of water absorbed by the different soil types during 15, 30, 45, and 60 min and the infiltration rates at the end of a 60-min rainfall are shown in Table 1 for the dry run and in Table 2 for the wet run.

The soils, with the exception of the Durham sandy loam which contained only 7 per cent clay, absorbed over twice as much water in 1 hr during the dry run as during the wet run.

TABLE 2. INFILTRATION DURING THE WET RUN

Soil type	Cumulative infiltration, in 15 min	30 min	45 min	60 min	Infiltration rate at the end of 60-min rainfall, iph
Madison clay loam	.14	.23	.30	.37	.25
Cecil clay loam	.26	.43	.54	.63	.37
Cecil sandy loam	.12	.15	.18	.21	.14
Durham sandy loam	.23	.37	.52	.68	.60

This paper was presented at a meeting of the Southeast Section of the American Society of Agricultural Engineers at Washington, D. C., February, 1948, as a contribution of the Office of Research, Soil Conservation Service, U. S. Department of Agriculture, in cooperation with the South Carolina Agricultural Experiment Station.

T. C. PEELE, O. W. BEALE, and F. F. LESESNE are soil scientists, Office of Research, Soil Conservation Service.

*Superscript numbers refer to appended references.

The infiltration rates after a 60-min rainfall during the dry run would probably be the best values to use in designing an irrigation system when only 2 or 3 in of water are to be applied to cultivated row crops affording little cover for the soil.

The effects of cover from crop residues on infiltration rates are shown by an experiment in which crimson clover hay, at the rate of 4 tons per acre, was spread on the surface of Cecil sandy loam as a mulch on two plots, and incorporated with the surface soil of two plots, while two other plots were maintained in a bare, cultivated condition for comparison. Infiltration of all plots was measured 6 months after the organic matter treatments were made. The results (Table 3) show

TABLE 3. EFFECTS OF SOIL TREATMENT ON INFILTRATION RATES OF CECIL SANDY LOAM

Treatment	Cumulative infiltration, in 15 min	30 min	45 min	60 min	Infiltration rate at the end of 60-min rainfall, iph
Bare—cultivated	.42	.57	.68	.77	.42
Organic matter incorporated	.51	.68	.81	.93	.49
Organic matter applied on the surface as a mulch	.86	1.56	2.18	2.74	2.18

NOTE: The organic matter was added at the rate of 4 tons per acre 6 months before the infiltration tests were made.

that the total quantity of water absorbed in 1 hr by the plots having a mulch on the surface was nearly 4 times that absorbed by the bare plots receiving no organic matter. The infiltration rate of these plots at the end of 1 hr of rainfall was less than one-fifth the infiltration rate of the mulch plots. Where organic matter was incorporated with the soil, only a small increase in infiltration rate over that of the plots receiving no organic matter was found. It is apparent from these data that sprinkler irrigation systems for areas where good soil cover will be present can be designed to apply water at a much higher rate than systems for bare areas.

Much of the irrigation practiced in South Carolina at present is in the truck farming areas near the coast on soils having very sandy surface horizons. The texture of these soils

TABLE 4. RELATION OF SOIL TEXTURE TO INFILTRATION RATES OF VERY SANDY SOILS

Soil No.	Mechanical analysis, per cent Sand	Silt	Clay	Infiltration rate at the end of 60-min rainfall, iph
1	98.6	0.4	1.0	3.50+
2	96.1	1.4	2.5	3.50+
3	92.9	3.0	4.1	1.15
4	89.9	5.3	4.8	0.75
5	86.8	7.5	5.7	0.61
6	80.8	11.0	6.9	0.60
7	78.3	12.2	9.5	0.24

has a considerable influence on the rate at which they can absorb water from rainfall or sprinkler irrigation. The relation of texture to infiltration rates, determined with the type F artificial rainfall apparatus, is shown in Table 4 for a few sandy soils. On level land when only two or three inches of water are to be applied, the water application rates for sprinkler irrigation could be increased to some extent over the infiltration rates shown in Table 4 because of the surface retention of ponded water which would soak into the soil after irrigation ceased.

Available Water-Holding Capacity. The available water-holding capacity of soils is used extensively in the western states as an index of the irrigation requirements of soils, but this type of information has not been available for soils of the southeastern states. Veihmeyer and Hendrickson[4] and others have emphasized the importance of considering this soil property when designing an irrigation system.

The available water-holding capacity of a soil is the moisture range between the permanent wilting point and the field capacity. The wilting point can be ascertained by growing plants in pots and determining the moisture content of the soil at which permanent wilting occurs as proposed by Briggs and Shantz[1], or by extracting the water from saturated soil in a pressure filter apparatus at 15 atmospheres pressure, measuring the percentage of water retained and converting this value to the wilting point by means of a regression equation. The relation of the per cent moisture retained in soils against a pressure of 15 atmospheres to the permanent wilting point measured by the plant method has been shown by Richards and Weaver[3] for a number of soils. Since the two methods do not quite give identical results, a regression equation correlating the results of the two methods was determined for South Carolina soils. The equation is: $Y=0.97X+0.99$, when X is the per cent moisture retained against 15 atmospheres pressure and Y is the calculated permanent wilting percentage.

The field capacity is the moisture content of a well-drained soil one to three days after the soil has been thoroughly wet by rain or irrigation and the excess water has drained from the soil. The field capacity can be calculated from moisture equivalent determination by means of the regression equation developed for South Carolina soils, where $Y=2.62+0.865X$, when X is the moisture equivalent and Y is the field capacity.

Laboratory determinations of wilting point and field capacity permit determination of available water-holding capacity on a percentage basis. The irrigation engineers need this information on a volume basis (surface inches or cubic feet per acre). Volume-weight measurements of the soil, using undisturbed cores, are needed for converting the percentage values to a volume basis. The available water-holding capacity, AWC, in surface inches per inch depth, can be calculated from the formula:

$AWC=$ (Per cent water at FC − per cent water at WP) / $100\times$ volume weight, where FC is the field capacity and WP is the permanent wilting point.

TABLE 5. AVAILABLE WATER-HOLDING CAPACITY OF DIFFERENT HORIZONS OF DIFFERENT SOIL TYPES

Soil type	Horizon	Clay content, %	Organic matter content, %	Available water-holding capacity per inch depth, in
Dunbar f.s.l.	A_1	5.8	4.38	.148
	B_1	19.1	0.86	.124
	B_2	25.8	0.42	.118
Charleston l.f.s	A	4.4	1.88	.096
	B	13.5	0.59	.075
Leaf s.l.	A	12.2	6.97	.205
	B	33.3	0.85	.099
Stono l.	A	5.3	24.64	.159
	B	8.5	8.01	.107
Portsmouth l.	A	11.8	6.47	.189
	B_1	8.3	0.23	.076
	B_2	20.1	0.31	.111
Coxville f.s.l.	A	19.1	4.69	.101
	B_1	40.2	0.70	.093
	B_2	45.0	0.43	.097
Grady l.	A	12.2	5.65	.125
	B	29.9	0.84	.128
Bladen f.s.l.	A	4.1	1.55	.101
	B_1	3.1	0.35	.048
	B_2	31.0	0.40	.156
Norfolk s.l.	A_1	2.4	0.75	.059
	A_3	3.2	0.62	.087
	B_1	29.0	0.52	.107
	B_2	30.1	0.25	.105
Lloyd s.l.	A	18.0	1.20	.112
	B_1	30.3	0.73	.112
	B_2	40.6	0.45	.100
Hayesville s.l.	A	8.2	0.96	.091
	B_1	31.4	0.53	.117
	B_2	34.1	0.26	.119
Cecil s.l.	A	8.1	3.15	.148
	B_1	45.9	0.89	.121
	B_2	50.0	0.55	.136

The field capacity in surface inches per inch depth of soil can be converted to cubic feet of water per acre per inch depth of soil by multiplying it by 3630, or to gallons per acre per inch depth of soil by multiplying it by 27,154.

The available water-holding capacities of a number of South Carolina soil types are shown by soil horizons in Table 5 and by depths of 12, 24, and 36 in in Table 6. The soil samples of all soils on which data are reported in Tables 5 and 6 were collected and their volume-weights determined by one of the authors (F. F. Lesesne) in connection with a permeability survey being made in South Carolina.

TABLE 6. SURFACE OF WATER REQUIRED TO RAISE THE SOIL MOISTURE CONTENT FROM THE WILTING POINT TO THE FIELD CAPACITY

Soil type	Available water-holding capacity in terms of surface inches of water: 0-12 in depth	0-24 in depth	0-36 in depth
Dunbar fine sandy loam	1.61	3.02	4.44
Charleston loamy fine sand	1.11	2.01	2.91
Leaf silt loam	2.04	3.22	4.41
Stono loam	1.91	3.19	4.47
Weston fine sandy loam	1.48	3.21	4.95
Portsmouth loam	2.27	3.29	4.56
Coxville fine sandy loam	1.16	2.32	3.48
Grady loam	1.52	3.06	4.59
Bladen fine sandy loam	1.00	2.66	4.53
Norfolk sandy loam	0.82	1.96	3.25
Hayesville sandy loam	1.27	2.68	4.11
Cecil sandy loam	1.59	3.13	4.76

The quantity of water that soils can hold in a form available for plant use is influenced mainly by the quantity of clay and organic matter in the soil and the physical properties of the clay. In general, soils which are low in clay and organic matter have low available water-holding capacities. Soils containing large amounts of organic matter usually have large capacities for holding water in an available form, while soils containing large quantities of clay may or may not be capable of holding large amounts of available water, depending on the characteristics of the clay. If the clay exhibits a low degree of swelling and shrinking on wetting and drying, or has a low base-exchange capacity, it is probable that it also has a low available water-holding capacity.

The correlation between organic matter content and per cent available water-holding capacity of twenty-five soils having sandy loam textures, based on mechanical analysis, was determined. The equation expressing the relationship is $Y=6.64+0.876X$, where Y is the available water-holding capacity in per cent and X is the organic matter content of the soil in per cent. The correlation coefficient of these properties is $r=0.869$. It is significant at the 1 per cent level.

The organic matter content of the soils on which the equation is based ranged from 0.31 to 5.65 per cent. Most of the samples came from the flatwoods section of the Coastal Plains area of South Carolina. It will be noted from the equation that an increase of 1 per cent in organic matter content produces an increase of 0.876 per cent in available water-holding capacity.

SUMMARY

Infiltration rates at the end of 1 hr of simulated rainfall on four Piedmont soil types with the soils loose and dry at the beginning of the test varied from 0.25 to 0.76 iph. Infiltration rates varied from 0.14 to 0.60 iph when the same soils were wet and compact at the beginning of the test. Organic matter added to the surface of Cecil sandy loam at the rate of 4 tons per acre increased the infiltration rate from 0.42 to 2.18 iph. The infiltration rate of sandy soils of varying clay contents ranged from 0.24 iph for a soil with 9.5 per cent clay to more than 3.5 iph for a soil with 2.5 per cent clay.

The available water-holding capacity of 12 soil types in surface inches of water ranged from 0.82 to 2.27 for the 1-ft depth, 1.96 to 3.29 for the 2-ft depth, and 2.91 to 4.95 for the 3-ft depth. Data showing the available water-holding capacity of different soil horizons were pre- *(Continued on page 161)*

Methods of Field Curing Hay

By T. N. Jones and R. F. Dudley
MEMBER A.S.A.E. JUNIOR MEMBER A.S.A.E.

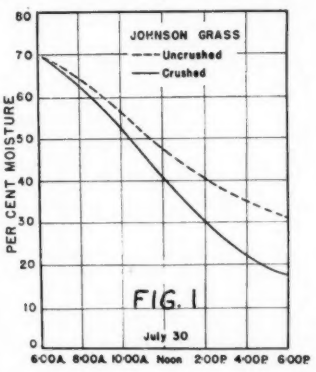
A STUDY was made during the summer of 1947 to determine the difference in curing hay by using a commercial field mower-crusher and the regular mower. The field mower-crusher (Haymaker) was manufactured by John Bean Manufacturing Company. This machine mows and crushes the hay in one operation. This is accomplished by having a crushing unit mounted directly behind the cutter bar. A pickup attachment elevates the hay to the rollers where it is crushed. The pressure on the rollers may be varied, depending upon the type of hay, but it should be adjusted so that the stems of the hay are cracked when they pass through the rollers. This permits the moisture in the stems to escape rapidly and decreases the time required to cure the hay.

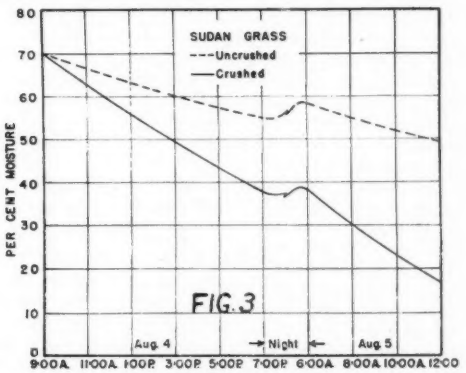
Tests were conducted on the Mississippi Agricultural Experiment Station property and with several farmers so field conditions existed in all tests. The tests were made on Johnson grass, soybeans, and sudan grass. The weather was ideal for curing hay in most of the tests. In conducting these tests the Haymaker and regular mower were started to work in the field at the same time, and moisture samples of the hay were taken every hour of the day and continued until both the crushed and mowed hay were ready to bale. After a few hours curing in the swath the hay was raked and finished curing in the windrow. Carotene samples were taken of the green hay, of the crushed and mowed hay at the time of baling, and after the baled hay had been stored for two months.

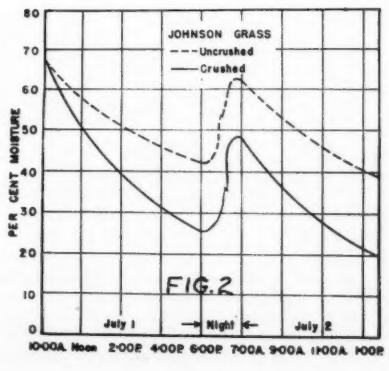
Fig. 1 shows the difference in the rates of curing for crushed and uncrushed Johnson grass cut late in the afternoon. There was practically no change in the moisture content from the time of cutting the Johnson grass at 5:00 p.m. to 6:00 a.m., so the graph was started at 6:00 a.m. on the second day. The moisture content of the crushed hay was reduced from 70 per cent at 6:00 a.m. to 17 per cent at 6:00 p.m., while the moisture content of the uncrushed hay was reduced from 70 per cent to 31 per cent over the same period of time. The total time for curing the crushed hay was 24 hr, while it was 45 hr before the uncrushed hay was cured enough for baling. Even though the crushed hay was cured in 24 hr, it should be noted that it was too late to start baling the hay at 6:00 p.m., and it had to remain in the field another night, which was undesirable. Fig. 2 shows the difference in the rate of curing for crushed and uncrushed Johnson grass cut at 10:00 a.m. The moisture content of the crushed hay was reduced from 67 per cent at 10:00 a.m. to 26 per cent at 6:00 p.m. and gained to 48 per cent overnight, due to a heavy dew, and on the second day it was reduced from 48 per cent at 7:00 a.m. to 20 per cent at 1:45 p.m. The moisture content of the uncrushed Johnson grass was reduced from 67 per cent at 10:00 a.m. to 42 per cent at 6:00 p.m. and gained to 62 per cent overnight and then was reduced from 62 per cent at 7:00 a. m. to 39 per cent at 1:45 p.m. The uncrushed hay was ready to bale on the third day, or after 48 hr of curing, while the crushed hay was ready to bale after 26 hr of curing. By cutting and crushing the hay in the morning it was ready to bale the next afternoon and remained in the field only one night while the uncrushed hay remained in the field two nights. The crushed hay had a better color and a higher carotene content.

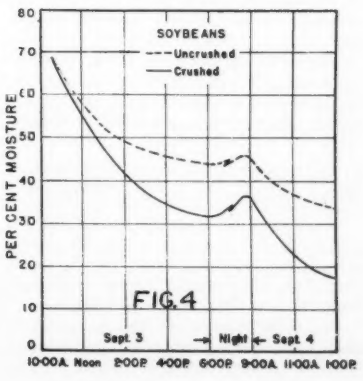
Fig. 3 shows the difference in the rate of curing of crushed and uncrushed sudan grass for hay. The moisture content of the crushed sudan grass was reduced from 70 per cent at 9:00 a.m. to 37 per cent at 7:00 p.m. and on the second day it was reduced from 37 per cent at 6:00 a.m. to 17 per cent at noon. The moisture content of the uncrushed sudan grass was reduced from 70 per cent at 9:00 a.m. to 55 per cent at 7:00 p.m. on the first day and on the second day it was reduced from 58 per cent at 6:00 a.m. to only 49 per cent at noon. The moisture content of the uncrushed sudan grass was not low enough to bale until the morning of the fourth day, or 72 hr after it was cut, while the crushed required only 27 hr to cure and was baled on the second day after cutting. A noticeable difference was found in this hay since the leaves of the uncrushed hay were overcured and shattered before the stems cured. The stems of the crushed sudan grass cured rapidly and most of the color was retained.

Fig. 4 shows the difference in the rates of curing for crushed and uncrushed soybeans. The moisture content of the crushed soybeans was reduced from 69 per cent at 10:15 a.m. to 32 per cent at 6:00 p.m. and gained to 36 per cent overnight, and then it was reduced from 36 per cent at 9:00 a.m. to 17 per cent at 1:00 p.m. The moisture content of the uncrushed soybeans was reduced from 69 per cent at 10:15 a.m. to 44 per cent at 6:00 p. m. and *(Continued on page 161)*









This paper was prepared expressly for AGRICULTURAL ENGINEERING.

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Determining the Temperature Gradient in Hay

By John B. Dobie
Junior Member A.S.A.E.

IT IS reported that the annual loss on farms in the United States due to spontaneous combustion is $20 million per year. A large part of these losses is due to spontaneous heating in hay, even in areas such as the interior valleys of California where field-drying conditions are such that hay finishing is considered unnecessary. In 1946 there were three fires caused by spontaneous heating of hay within ten miles of Davis, Calif.

It is difficult to ascertain from available literature the exact chemical changes that take place in a pile of hay which is heating spontaneously. Various theories have been suggested; and while the solution of this problem does not fall in the field of engineering, it is of interest to those engineers working with forage crops. However, the part of the problem which involves measuring temperatures in a stack of hay which is heating spontaneously is at least partially an engineering problem. An excellent opportunity was afforded to study this problem when, on June 25, 1946, a barnful of hay on a farm near the University was reported to be heating spontaneously. Since the hay was already in the barn, there was no opportunity to install the usual type of thermocouple, thus necessitating the development of some type of temperature-measuring device which could be inserted into the existing stack.

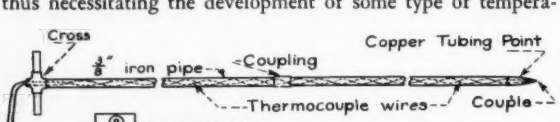

Fig. 1 Original temperature probe with separate potentiometer

To fill this need, a ten-foot probe was constructed of ⅜-in iron pipe with a piece of ⅜-in copper tubing drawn to a point and sweated into one end to form a pointed tip (Fig. 1). The other end was provided with a cross and pipe handles. A thermocouple of copper and constantan was made at the very tip of the copper point, and the connecting wires run back through the pipe to a potentiometer. Temperature readings could be made at any point in this pile of hay with this unit. It was found that it took a few seconds for this thermocouple to come to a maximum reading due to the high heat conductance of the copper point. However, it was possible to take about one reading per minute, permitting numerous readings to be taken until the center of heating in the stack was found. Readings were taken daily until spontaneous combustion occurred 17 days later.

The barn had been completely filled (20 ft deep) with chopped alfalfa hay. The lower ten feet of hay was first cutting and the upper layer second cutting. The center of heating seemed to be about where the two layers met, or possibly in the lower portion of the upper layer. The first cutting had been in the barn six weeks and the second cutting two weeks. Since no heating had been noted in the first layer before the second cutting was put on top, it was assumed that heating had been taking place less than two weeks. When the first measurements were taken, the interior of the stack was hot throughout. There were two centers of heating at widely separated points, as shown in Fig. 2, registering a maximum temperature of 200 F.

The entire stack of hay, which had settled to about 14 ft in height, was wet and sticky as evidenced by the probe when removed from the hay. An odor similar to that of acetic acid was present in the barn. For a period of ten days, the temperature rose at the rate 2 to 3 deg per day until it reached 233 F. Up to this point, the hay in the stack remained very moist. The temperature was fairly constant at about 233 F for several days, but the hay was drying rapidly as shown by the probe when removed from the stack. The sweet, acetic acid odor had changed to a pungent, scorched stench, which was very irritating to the nostrils. Data taken the 17th day revealed a very abrupt rise to over 350 F with the hay on the inside of the stack extremely dry. In order to save the barn, the hay was wet down immediately and removed the next day. A small blaze occurred that night but was easily extinguished. Several fires broke out in the hay as it was removed from the barn, but were controlled by keeping the top of the stack wet down through use of a rural fire truck. Much of the hay burned after it was stacked in the field. The stack had shrunk to approximately half its original depth by the time the hay was removed.

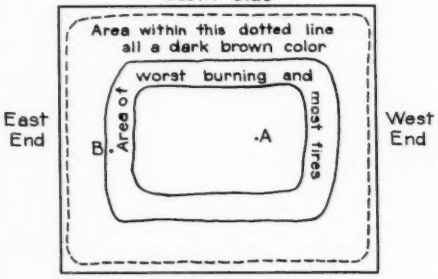

Fig. 2 Plan view of hay in barn showing areas of greatest heating

The time-temperature gradient corresponded rather well with the sequence of events as outlined by Laupper* in his theory that pyrophoric iron is the element necessary to cause spontaneous combustion. These observations start at a relatively high temperature; but it was interesting to note the gradual temperature rise from 200 to 233 F, the static condition at 233 F for several days, and the subsequent accelerated rise in temperature after the water distillation was completed and as the hay was dried out. Unless kept wet down, the hay burst into flame whenever exposed to the air.

As the hay was removed, it was noted that fires broke out in all parts

*Brown, Charles A. The Spontaneous Combustion of Hay. USDA Tech. Bull. No. 141, September, 1929.

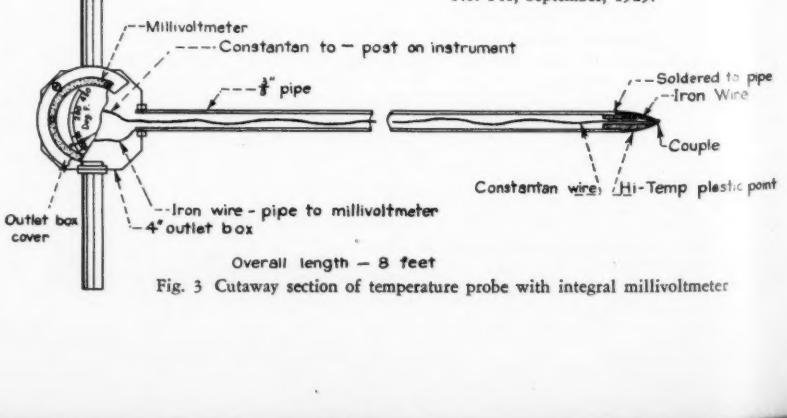

Fig. 3 Cutaway section of temperature probe with integral millivoltmeter

This paper was presented at the winter meeting of the American Society of Agricultural Engineers at Chicago, Ill., December, 1947, as a contribution of the Farm Structures and Rural Electric Divisions.

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of the pile. However, there was considerable variation in the color of the hay in various parts of the stack, ranging from light tobacco brown around the edges to dark brown in the center and with a ring of black hay around the center and about halfway between the center and the edges of the stack (Fig. 2). This black hay corresponded to an area where men had walked in spreading the hay around the barn. The point of highest temperature was in this region.

The purpose of the temperature probe in this study was to obtain figures on the rate of temperature rise in the hay and the location of maximum temperature in the stack. However, it proved successful enough that it should have a practical use in determining whether hay is heating sufficiently to necessitate its removal in order to save the barn. Such a probe kept in the county agricultural agent's office could be used to serve an entire county. The type of potentiometer used is too expensive and is unnecessarily accurate for a portable unit such as might be used by county agents. Therefore, a more practical and less expensive temperature probe was designed to fill this need.

This probe is similar to the one previously described, with a small millivoltmeter mounted on the rear end to make a self-contained unit. A ⅜-in iron pipe is used for the probe. This size was proven sufficiently rigid in lengths up to 10 ft without being too difficult to force into a stack of hay. During the water distillation part of the process, hay heating spontaneously is very wet and sticky and offers considerable resistance to any such probe. Therefore, the probe should be reasonably smooth and without obstructions or joints in order to reduce friction.

The point of the probe is made of high-temperature resistant laminated plastic. This reduces the rate of flow of heat from the tip back through the pipe, permitting quicker readings and a more accurate measurement of the temperature at the tip. The hot junction of the thermocouple is located in the tip of the plastic point, partially counter sunk to prevent damage during insertion and removal from the hay. The point is tapered from the same diameter as the pipe to a blunt bullet shape. The pipe is threaded on the inside to take the plastic point.

An iron constantan couple has been used to simplify construction. From the hot junction, the iron wire is threaded through a hole bored diagonally through the plastic point from the tip to the iron pipe. The wire is brazed to the pipe with a direct iron to iron contact, making the pipe the iron conductor from the couple to the instrument. An iron wire is used to connect the pipe to the registering instrument at the other end. Another hole drilled lengthwise from the tip of the plastic point carries an insulated 16-gage constantan wire. This wire is carried through the pipe to the registering meter. This temperature probe is shown in Fig. 3.

The registering instrument is a low-resistance millivoltmeter with a built-in compensating resistance to reduce the effect of variation of ambient temperature at the meter. The meter circuit is primarily copper, which has a large temperature coefficient of resistance, necessitating the insertion of a suitable negative resistance. Instrument manufacturers, when provided the necessary information, build the compensating resistance into the millivoltmeter.

The millivoltmeter has a 2½-in circular dial in a flush-mounted metal case and is mounted in a 4-in outlet box which is fastened to the end of the pipe. Handles are fastened on the sides of the outlet box to aid in pushing the probe into the haystack. The instrument is quite rugged and can be transported in an automobile without danger of injury.

The probe built at the California Agricultural Experiment Station was approximately 8 ft long to facilitate carrying in an automobile. The resistance of 8 ft of constantan wire is 0.9 ohm, and the iron pipe is sufficient to make the total external resistance about 1 ohm. The instrument was adjusted for approximately one milliampere at full scale and to a resistance of 11.5 ohms. This when used with 1 ohm in series gave a full-scale value of 12.5 millivolts, the Bureau of Standards rating for 450 F. The scale was marked 50 - 0 - 450 F. Zero on this scale is ambient temperature at the meter since the cold junction is at the meter and no ice pot is used. Thus the ambient temperature must be added to the reading on the millivoltmeter to obtain the correct temperature at the hot junction of the thermocouple. The meter may be read to 5 F.

The millivoltmeter may be ordered to fit the temperature range necessary. When the desired temperature range is known, the maximum electromotive force in millivolts may be obtained from Bureau of Standards data. The full-scale amperage may be determined by calculation once the voltage and resistance are known.

This temperature probe may be built for $20 to $25. The millivoltmeter is the principal cost, amounting to $15 to $20. Construction is simple and inexpensive.

This temperature probe, having been developed primarily for use by county agents and others working in the field, is not intended to be used where extreme accuracy is desired. It affords a method of rapidly exploring the interior of a haystack for hot spots and determining their temperature. The temperature indication is obtained in a few seconds, permitting numerous readings in a short time. By means of this instrument, the temperature gradient of hay which is heating spontaneously may be charted, both as to time and location in the stack. If the hay becomes dangerously hot, it may be removed from the barn, thus saving the barn, livestock, and equipment.

Field Curing Hay

(Continued from page 159)

gained to 45 per cent overnight and then it was reduced from 45 per cent at 9:00 a.m. to 34 per cent at 1:00 p.m. The uncrushed soybeans were not ready to bale until the third day, or 49 hr after they had been mowed, while the crushed soybeans were ready to bale on the second day, or 25 hr after being cut and crushed. The loss of the beans due to shattering was less for the crushed hay, since the pods were not overcured. The crushed soybeans also retained more color than the uncrushed beans.

By crushing large-stemmed hays, such as Johnson grass, soybeans and sudan grass, the time required for field curing may be reduced from one-half to one-third as compared to mowed hay. Crushed hay retains more color than mowed hay. Since crushed hay can be baled before the mowed hay, there is less possibilities of damage caused by rain.

The carotene content of the crushed hays at the time of baling was approximately 35 per cent higher than in the uncrushed hays at the time of baling. After the crushed hays had been stored for two months the carotene content was also about 35 per cent higher than in the uncrushed hays that had been stored an equal time.

Irrigation Requirements

(Continued from page 158)

sented. These data provide a basis for estimating the available water-holding capacity of similar soils.

The available water-holding capacity of sandy loam soils was found to increase at an average rate of 0.876 per cent for each per cent increase in organic matter content.

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A Correction

ATTENTION has been called by the author to the fact that Figs. 2 and 3 were transposed in the paper entitled "Engineering-Management Aspects of Self-Propelled Machines", by E. L. Barger, on pages 106 and 107 of AGRICULTURAL ENGINEERING for March, 1948.

Agricultural Engineering Challenges in the Southeast

By E. V. Smith

THE problems confronting all segments of the agricultural engineering profession, as we move toward greater mechanization, are more challenging in the Southeast than they are in certain other areas of the South, such as the Mississippi Delta and the High Plains.

Before the war, the dense agricultural population in the South tended to hinder the advancement of mechanization in the region. Human labor on the farm was plentiful and cheap. Even today our farmers produce too little per man hour; or, to put it another way, they expend too much labor per unit of produce. In 1943, for example, the average labor charge to produce 100 bu of corn in South Carolina, Georgia, Alabama, and Mississippi was 247 hr as compared to 46 hr in four Midwest states. In the same four Southeastern states, from 200 to 250 hr were required to produce a bale of cotton, and in Georgia and Alabama, approximately 200 hr were required to produce a ton of peanuts. The figures for the Southeast today probably are little different from those quoted for 1943; the migration from the farm during and since the war, however, has been sufficient to intensify interest in mechanization.

Mechanization of agriculture, therefore, imposes a real responsibility on the agricultural engineers who serve the region. This statement applies not only to the research engineer, but to the extension engineer and to the design engineer and manufacturer of farm machinery as well.

It has often been said that cotton and peanuts are among the few major crops remaining to be fully mechanized. These are two of the three chief cash crops of the Southeast.

Let us examine the situation with respect to the need for mechanization of these crops, considering cotton first. The competition that cotton faces from synthetics and from foreign producers has been widely emphasized. In addition, the cotton grower in the Southeast faces keen competition from other producing areas in this country, such as the Mississippi Delta and the High Plains. Cotton production in both of the latter areas is already mechanized, or the research foundation for such mechanization has been laid. The four-row cultivator, the flame cultivator, and the spindle-type picker are actualities in the Delta and similar cultivators and strippers on the Plains. In contrast to the 200 man-hours or more now required to produce a bale of cotton in the Southeast, only 15 to 30 hr may be required in the Delta and Plains areas under complete mechanization.

The mechanization of cotton in the Southeast, therefore, is a real challenge to the agricultural engineer. The generally small farms, small fields, and rolling to hilly topography of the region all add to the difficulties of the problem.

Of approximately 120 hr required to produce an acre of cotton in the Southeast, 50 hr or more are consumed in harvesting the crop. The high labor requirement for hand picking imposes a problem not heretofore mentioned in this paper. So much of the time and energy of the farmer and his entire labor force are used in picking cotton during the fall that the planting of winter legumes and winter grazing crops is prevented or seriously delayed. The development of a satisfactory mechanical method of harvesting that is cheap enough to be used on small cotton farms would break one of the principal bottlenecks to a well-rounded farming program for the region.

Peanuts, like cotton, may be expected to face keen competition in the not too distant future. It is also a crop with a high labor requirement, about 200 hr being required for the production of a ton in Georgia and Alabama. The competitive position of peanuts should be materially strengthened by the development of an economical mechanization program. Although some further advancement in the mechanization of production can be expected, the greatest saving in labor should result from the mechanization of post-harvest operations. This is a subject that has commanded the attention of several of you agricultural engineers during the past few months.

The problem of post-harvest mechanization is complicated by a number of unknowns at the present time. I will raise a few questions to illustrate the point. Should peanuts be cured in the stack, the windrow, or picked green and cured artificially? If they are to be stacked, how can they be handled to reduce the present high labor charge? If cured in the windrow, what about the effect of inclement weather on the quality of nuts and hay? If picked green, how will they be cured, and what will be the effect of curing on quality? What are manufacturers doing about modernizing pickers or combines? Does the research engineer know enough about the kind of machine needed to advise the designer? Such questions point to the engineer's responsibility to the peanut grower of the Southeast.

Thus far I have dealt with the mechanization of specific crops and with the engineer's responsibility in the development of such mechanization. Let us consider now a broader aspect of mechanization. Cotton, tobacco, and peanuts occupy but 8.5 million of the 40.5 million acres of crop and pasture land available to the farmers of South Carolina, Georgia, Alabama, and Mississippi; although these three crops occupy only 21 per cent of the available land, they produce 54 per cent of the income.

Probably no informed agricultural worker believes that any of these crops can be materially expanded in the Southeast. It is generally believed, however, that the remaining 79 per cent of the crop and pasture land can be made to produce a much greater share of the farmer's income that it does at present. A number of Southern agricultural experiment stations are developing research programs on livestock directed toward that objective.

The need for power machinery and mechanical know-how is immediately exaggerated by the introduction of livestock into the picture; this is especially true when the livestock are beef or dairy cattle and when small farms are considered. More power is needed to fallow land for winter grazing crops than to prepare it for planting cotton. Similarly, more complicated machinery is required for efficient haying than has generally been used in the cultivation of cotton on small farms.

Finally, there are many other ways in which the agricultural engineer can serve the Southeast. Terracing and soil conservation; irrigation; rural housing; and seed, grain, and hay curing are among the more important fields that might be discussed if time permitted.

In conclusion, let me say that each segment of your profession has a distinct responsibility to our region. That of the research engineer has been discussed at some length in this paper. The extension engineer has a big job in helping the farmer translate the results of research into farm practice. The designer must design and the manufacturer make equipment adapted to our needs.

This paper was presented at a meeting of the Southeast Section of the American Society of Agricultural Engineers at Washington, D. C., February, 1948.

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Cotton Mechanization

IF AMERICAN grown cotton is going to hold and expand its markets in competition with foreign growths and synthetic fibers and still be a profitable enterprise, production costs must be cut. Increased efficiency is the best hope of keeping the industry on a sound and profitable basis. This applies all the way along the line from cotton farms to consuming mills. Though our scientists and engineers are attacking the problem from all possible angles, mechanization seems to hold the greatest promise. (From remarks by E. D. White, at a recent conference sponsored by the National Cotton Council of America, reported in "Farm Equipment Retailing," April, 1948.)

"Dependable Precipitation"

By Hayden K. Rouse

REPORTS of precipitation data are limited largely to tabulations of records which have been collected in the past. These tables usually include a mean or average value called a "normal". In farm planning, the use of "normals" may be deceptive. They tend to mislead those not familiar with the locality. They give no idea of the size or frequency of the departure from "normal". To obtain a true picture of what may be expected, the farm planner must have the complete record. He must go through it month by month and year by year. Only with information obtained in this way can he appraise the risks and opportunities. An aid toward sound judgment would be usable data giving amounts of precipitation that he can depend on with a known degree of regularity. In this paper the author will attempt three things. He will show the dangers in the use of "normal" values. He will show the need for a new type of precipitation data. He will discuss a plan to give the farm planner data on dependable precipitation.

For this purpose, dependable precipitation is defined as the amount of precipitation that will be equalled or exceeded in a given proportion of time. It is the amount that the farm planner can count on with a known probability. This amount varies from place to place. It varies in an inverse ratio with the proportion of time. For example, at Colorado Springs, Colo., July precipitation will be 3.65 in, or more, in 20 years out of 100. In 80 years out of 100, July precipitation will be 1.60 in, or more. As the proportion of time rises from 20 to 80 per cent, the dependable precipitation drops from 3.65 to 1.60 in.

In humid regions there may be wide fluctuations in precipitation. Even in dry years, however, amounts are enough for moderate crop yields. Disastrous drought may occur but once in a lifetime. By contrast, in subhumid and drier climates, crop failures due to drought are not uncommon. Most of our farm lands between the 95th and 120th meridians are subject to this hazard. To meet the risk, farm plans must provide for the accumulation of sufficient reserves when yields are good for sustenance when crops fail. The proportion of the years when crops fail due to drought varies from place to place. It also varies with the type of farming, since some crops need more water at critical periods than others.

The author chose the High Plains as the place to demonstrate the method. He has first-hand knowledge of its terrain, peoples, and problems. Physical conditions vary enough to make the demonstration interesting. Altitude rises from 3000 to 7000 ft. The surface varies from flat to rolling. The climate is subhumid or drier. Most of the records were available.

On many farms in the High Plains the main crop is grain. On others, livestock and feed are grown. Here, based on experience, farmers have a rule-of-thumb guide of crop failure due to drought once in five years. Successful farmers store supplies of feed and seed and build up bank accounts during the 80 per cent of years when yields are good. These reserves carry them through the 20 per cent when drought may be expected to cause loss of crops. With other types of farming sufficient reserves may be built up in three years out of five (60 per cent of the time) to last through two drought years. Under very special conditions it may be possible to produce enough in one good year (20 per cent of the time) to balance failures in four poor ones. An example of this is the non-resident operating large acreages of low-cost land with highly mechanized equipment.

To plan well, the farm planner must know the moisture needs of crops at the several stages of growth. It is as important that he have some assurance of the amounts of precipitation he can depend on to meet these needs. The so-called "normal" precipitation will not do. Confusion exists because of the differing definitions of the word "normal". Its meaning in U. S. Weather Bureau and most other reports is the same as average or mean. Other definitions are found. In many farm planners the word "normal" excites the same thoughts as its synonyms: common, natural, ordinary, regular, typical, usual. They seldom realize the great proportion of the time when the departure from "normal" is large. They may not consider its significant effect on yields.

In the High Plains, the number of times when precipitation falls below "normal" is greater than when it exceeds "normal". This is true for all intervals, months, quarters, or years. It was found in all of more than 200 records. For example, in Cheyenne, Wyo., 62 per cent of the Julys had less than "normal" precipitation. At Burlington, Colo., the proportion was 58 per cent. At Amarillo, Tex., it was 59 per cent. The very broad departure from "normal" is shown by study of the records of July precipitation. Amarillo, Tex., Burlington, Colo., and Imperial, Neb., were chosen as representative of the southern, central, and northern parts of the High Plains. These three places have records of more than average length. Their records cover the same span of time. The three towns are all close to the 102nd meridian. On the average, in 68 per cent of the years the actual July precipitation departed more than 25 per cent from "normal". In 38 per cent of the years, the departure from "normal" was more than 50 per cent, plus or minus.

Such records indicate a broadly variable state. They show that there is a larger proportion of drought years here than in places where precipitation is less variable even though the "normal" be the same. They show why good farmers conserve larger shares of the yields in good years to help them to carry on through drought.

This plan of computing dependable precipitation uses methods of frequency analysis applied to U. S. Weather Bureau records. The same methods are widely used in determining probable peak rates of flood flow. They have been used to compute rainfall intensity frequencies. The methods involve the principle of sampling and the laws of chance. In using these there is no intent to ignore those laws and forces which control amounts and distribution of rainfall. Rather, it is felt that some of these laws are not yet fully understood. Not all of the forces can be measured. Some of them are thought to originate beyond this planet. Together they form a complex pattern. Their net effect seems to be about that which would occur if precipitation were subject to laws resembling those of pure chance. (As is shown later, smooth *curves* are drawn through points plotted on logarithmic-probability paper rather than *straight lines* as would be necessary if precipitation were assumed to follow strictly the laws of chance.)

Stations were chosen from those whose records are published by the U. S. Weather Bureau. A search was made to find records which covered periods of at least 40 years. As far as possible, places were chosen to form a square grid pattern about 40 miles on each side. In parts of the High Plains it was not possible to meet all these standards. In the sparsely populated or recently settled districts, 40-year records do not exist. Towns with long records may be far apart. Here it was necessary to use a few stations with shorter records. No record of less than 32 years was used. Here, also, distances between stations had to be much greater than planned. In all, 225 stations were chosen and their records assembled.

The compilation for each station includes its whole life up to the end of 1944. A few of the stations had been closed before this date. The compilation of these is brought up to the end of the last full year. This procedure brings together records of differing lengths. A few records are from 32 to 40 years. Most of them are 50 to 75 years. There can be no valid objection to this. Records of differing lengths are not mixed in the same series. The computations are for but one

This paper was presented at the annual meeting of the American Society of Agricultural Engineers at Philadelphia, Pa., June, 1947, as a contribution of the Soil and Water Division.

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station and use only one record. The analysis serves to fix the most probable value for that one place.

An analysis was to be made of each record to obtain the amounts of precipitation for 4 degrees of dependability. Proportions of 80, 60, 40, and 20 per cent of the time were selected as corresponding to 4, 3, 2, and 1 year out of five. Values were to be derived for each month and quarter and for the growing season and year. The analysis follows the methods given by Hazen[2] in "Flood Flows". The amounts of precipitation are listed in chronological order. They are then compiled in order of descending magnitude. The plotting position is computed in "per cent of time". The results are plotted on logarithmic-probability paper designed by Hazen, Whipple, and Fuller. Per cent of time is the abscissa on the probability scale with the corresponding amount as ordinate on the logarithmic scale. A smooth curve is drawn through the plotted points. The amounts of dependable precipitation are then picked from the curve as ordinates corresponding to the selected proportions of time as abscissas.

Maps were to be drawn to put these results in form for use in the field. These maps show the areas where amounts of dependable precipitation are about the same. One series of maps was to be made for each of the 4 degrees of dependability. Each series was to have 18 maps, one for each month and quarter and one each for the growing season and full year. These maps are made by locating each station on a base map. The dependable precipitation for that place is put on the map. Lines to show equal amounts are drawn in the same way as lines showing equal elevation on contour maps. Where there is doubt as to the right location for a line, more weight is given to the values at places with long records. This is done since a basic principle of sampling is that the larger the sample, the more reliable. In the High Plains, near the foothills, it has been observed that amounts of precipitation increase with the elevation. This fact is considered in locating lines of equal precipitation where there are no station records. It results in these lines having curvature over divides between streams resembling that of contour lines.

Soon after the work was well started it was necessary to stop in favor of urgent war jobs. It has not yet been possible to resume the work. Before this interruption some advance data had been prepared. This covered the High Plains of eastern Colorado and New Mexico in the series of 80 per cent dependability. Maps were drawn for the first and fourth quarters, the months of April, May, June, July, August, and September, and for the full year. It had also been possible to draw maps for July showing the amounts of precipitation for each of the four degrees of dependability. Samples of these maps are shown in Figs. 1 and 2.

This method of showing precipitation data is not offered as a cure-all or panacea. It is suggested as a new tool to be used with other information. It is still necessary to know whether snow, rain, or hail is the usual form of precipitation at critical seasons. It is an aid to know the manner in which it occurs. All of a gentle, soaking rain may enter the soil. Much of the moisture from a violent thunderstorm may be lost as runoff.

It helps to know that these results are based on the theory of sampling and a distribution which follows laws resembling the laws of chance. In tossing a coin, in a few tries, say, five, it may happen once in a while that all tosses show "heads". It may be that all will show "tails". As the number of tosses increases to, say, 100 tries, it is increasingly probable that "heads" and "tails" will turn up in about the same number. So, in a somewhat similar manner with these results, while 80 per cent of the time represents 4 years out of five, in any 5-year period amounts less than those shown may not occur at all. They may occur once. They may occur several times. Based on a long time, however, say, a century, it is probable that smaller amounts will not occur in more than about 20 years out of the hundred.

The accuracy of these amounts should be good if the use of this method of analysis is acceptable. The records used average 49 years in length. The values are picked from curves at spots well within the limits of the plotted points. No extension of curves was necessary. The information on the maps is generalized. The effects of local topography can not be shown. The records used include *(Continued on page 166)*

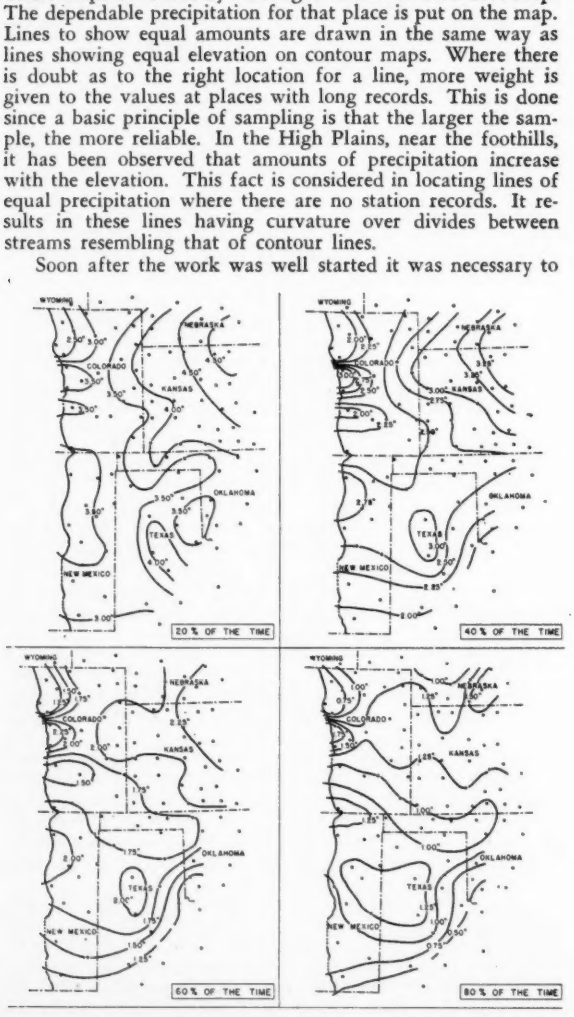

Fig. 1 July rainfall likely to be equalled or exceeded 20, 40, 60, and 80 per cent of the time

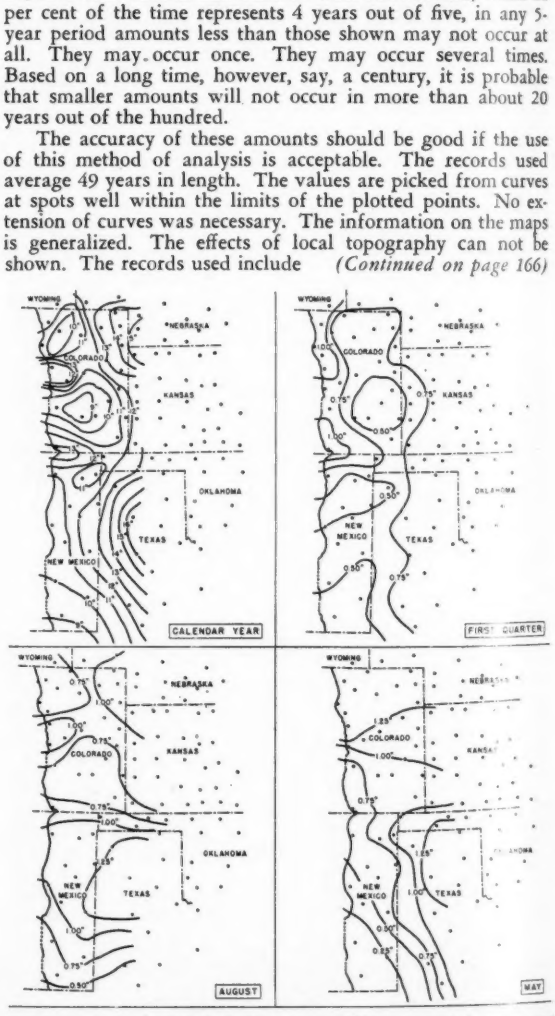

Fig. 2 Amount of rainfall likely to be equalled or exceeded 80 per cent of the time (four out of five years)

A Course in Agricultural Hydrology

By R. H. Dubois
Junior Member A.S.A.E.

PROBLEMS of drainage, erosion control, and irrigation fall naturally into the field of agricultural engineering. Almost without exception, students of agricultural engineering have a first-hand knowledge of farm life and farming problems, which is all-important when working with farmers and designing practical water-handling systems for a farm. This is not often true of graduates of other engineering curriculums in addition, the agricultural engineering curriculum gives a man a background of surveying, mathematics, geology, physics, soils, crops, and related subjects which enable him to handle the technical phases of these problems. In order to further strengthen training for work in this particular phase of agricultural engineering, a course, entitled "Agricultural Hydrology", has been incorporated into the agricultural engineering curriculum at Kansas State College.

The science of hydrology encompasses much more than the quantitative measurement, orderly presentation, logical analysis, and interpretation of records showing precipitation, stream flow, evaporation, infiltration, and other intimately related phenomena. It properly includes the occurrence, composition, properties, transformations, combinations, and movements of the waters of the globe*.

A study of hydrology as applied directly to agriculture should acquaint the student with the above-mentioned subjects, and, in addition, their relationship to crop production, drainage, irrigation, and erosion control.

As presented at Kansas State College, the course consists of two hours of recitation and three hours of laboratory work per week for a period of eighteen weeks. This course is a prerequisite to a four-credit-hour course in soil and water conservation.

Following is a basic outline of the material which is covered by recitation assignments:

I Precipitation
- A Forms
- B Sources
- C Occurrence (geographical)
- D Characteristics
  - 1 Intensity - Frequency
  - 2 Duration
  - 3 Distribution (seasonal)
- E Reporting, analysis, and application of records

II Surface Runoff
- A Sources
- B Measurement
- C Reporting, analysis, and application of records
- D Relation to
  - 1 Cover
  - 2 Land use
  - 3 Precipitation
  - 4 Soil characteristics
  - 5 Temperature
  - 6 Topography
  - 7 Stream flow
  - 8 Evaporation - Transpiration

III Evaporation and Transpiration
- A Factors affecting
- B Plant requirements
- C Application to drainage, irrigation, farm ponds, runoff, and other agricultural uses

IV Infiltration and Deep Seepage
- A Factors affecting
- B Rates and amount

V Classification of Climate
- A Precipitation
- B Temperature
- C Evaporation
- D Drought expectancies
- E Excessive precipitation expectancies

VI Climate and Crops
- A Ecology of crops as affected by
  - 1 Length of growing season
  - 2 Seasonal precipitation
  - 3 Temperature (mean and extremes)
  - 4 Latitude (length of day)

VII Ground Water
- A Occurrence
- B Movement
- C Yield
- D Relation to
  - 1 Soil
  - 2 Topography
  - 3 Stream flow

VIII Flow of Water
- A Open channels
  - 1 Natural streams
  - 2 Canals and flumes
- B Closed conduits
  - 1 Tile lines
  - 2 Irrigation pipe
- C Measuring devices

IX Soil-Water-Plant Relationships
- A Utilization by plants
- B Movement of soil water
- C Measurement of soil moisture
  - 1 Means of expressing
  - 2 Methods of measurement

Laboratory work is coordinated as closely as possible with the current recitation schedule. A detailed discussion of each laboratory exercise is not within the scope of this paper. However, a list of the laboratory exercises, and a brief description of the subject matter of each follows:

No. 1 Care and Adjustment of Surveying Instruments
- (a) Adjustment of the compass
- (b) Adjustment of the Wye & Dumpy level
- (c) Adjustment of the hand level
- (d) Adjustment of the transit

No. 2 Study of Weather Instruments, Charts, and Data
- (a) Study of purpose, operation, maintenance, and record obtained from each type of weather instrument
- (b) Study and analysis of record of actual single storms
- (c) Study and analysis of past records

No. 3 Analysis of Rainfall - Runoff Data
- (a) Plot hydrograph and rainfall curve for a selected storm on an experimental watershed
- (b) Analyze and report the results

No. 4 Study of Stream Gaging Methods
- (a) Determine the flow of a stream by (1) slope-area method, (2) current-meter method, and (3) float method
- (b) Compile the data and compare the results of various methods of gaging

No. 5 Study of Suspended Silt Load in Streams
- (a) Collect and analyze samples of water from a stream
- (b) Compile the data obtained

No. 6 Study of Water-Measuring Devices
- (a) Parshall flume
- (b) Trapezodial weir
- (c) Triangular weir (To be incorporated)
- (d) Rectangular weir

No. 7 Watershed Mapping Procedure
- (a) Cross-section method: (1) Level and chain; (2) level, transit, and plane table

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This paper was prepared expressly for AGRICULTURAL ENGINEERING.

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*Davis, C. V., Handbook of Applied Hydraulics, Section 2 by C. S. Jarvis, McGraw-Hill Book Co., 1942.

(b) Stadia method: (1) Level, transit, and plane table; (2) transit and plane table (elevations by vertical angles), (3) transit and plane table (elevations by Beaman arc)
(c) Photogrammetry (use of aerial photographs) (To be incorporated)

No. 8 Soil Studies (Collect samples and determine for several soils)
(a) Mechanical analysis (hydrometer method)
(b) Drainage properties (tensiometer method)
(c) Hygroscopic moisture
(d) Specific gravity
(e) Field capacity
(f) Pore space
(g) Volume weight

The subject matter as covered by this outline is undoubtedly covered in various courses at other schools. Part of the material was originally presented in other courses at this school. However, it seemed advisable to bring the material together under one subject, thus creating better coordination of the subject matter. Doing so allows a more complete coverage of material in the courses which were relieved of subject matter incorporated in the course entitled "Agricultural Hydrology". As an example of this, it may be noted that laboratory exercise No. 7, "Watershed Mapping Procedure," part (a), consists of instruction in mapping by the cross-section method. During the performance of this exercise, proper mapping procedure is stressed. However, the map which is produced is retained by the student and used the following semester, when he plans either a drainage or irrigation system, as the case may be, for the particular piece of land. In this way, there is no necessity for using laboratory time from the following course (Soil and Water Conservation), for making of maps. The student can spend his time more profitably on the technical planning of water-handling systems. Laboratory exercise No. 8, Soil Studies, is used in the same manner. Samples are collected and analyzed from fields which will be used for problems in the following course. It has been found that this allows efficient utilization of limited laboratory time, and actually makes the agricultural hydrology laboratory serve a dual purpose.

There has been no textbook assigned to the course, since at present it seems to be advisable to use abstracts from scientific journals, federal government publications, and state bulletins as a source of material, with occasional assignments from appropriate texts.

There is a serious need for a text covering the subject of agricultural hydrology. There are several excellent books dealing with the subject of hydrology, but in nearly every case the contents are designed for use in the study of large watersheds of many thousands of square miles. It would seem that the proper approach from the standpoint of agricultural hydrology would be that of the study of the hydrology of comparatively small watersheds, such as are encountered in the design of drainage systems, irrigation plants, soil and water conservation plans, and farm water supplies.

"Dependable Precipitation"

(Continued from page 164)

the most severe drought years of recent history. For this reason, it is thought that the amounts are conservative and safe for use.

The intervals of time covered by the maps are months or multiples of months. Maps for other periods are needed. Some crops go through droughts lasting longer than one month. Their critical period may be six weeks. The critical period for others may begin in the middle of a month. Finnell[1] found evidence that rain during the 30 days after July 15th might be the most important single factor influencing the yield of wheat in the northern High Plains. There is no technical obstacle to making maps for periods of any length. There are practical difficulties when the period is not a calendar month or multiple. Now, few records of precipitation are summarized by other than calendar months. At best the work of listing, summation, and tabulation of records for periods of full months is time consuming. It can be done at reasonable cost only because monthly totals have been compiled. When the base period is other than calendar months, totals must be compiled from daily records. This increases the work several times, making costs prohibitive. Still the critical periods of some plants do not conform to the calendar. There is a need for dependable amounts for periods other than calendar months. Some climatologists advocate a review of records of precipitation. They suggest summaries by 10 or 15-day periods. Such summaries would reduce the cost of making the additional maps that are needed.

There are many uses for precipitation data shown in this manner. At times plant varieties prove not adaptable when tried in new places. This may be explained by lack of dependable moisture at critical periods. Finnell[1] studied the factors which affect yields of winter wheat in the southern High Plains. He found that July rain was the most important single influence. Knowledge of July rainfall that can be depended on would assist in judging if winter wheat should yield well in similar areas. Data in this form will help the farm planner make better plans. The soil surveyor may use it in determining land-capability classes. It will help him decide on the practices and crops he will recommend. The plant breeder knows the moisture needs of his new plants during the stages of growth. With this data he may avoid introducing them in places where rainfall can not be depended on when the plant needs it most. An investor will find the data useful in appraising farms or ranches. The banker may use it in deciding to make a loan.

This offering of precipitation data does not involve anything new or untried. The methods of analysis have been in common use for many years. They are accepted by most hydrologists. They are taught by the U. S. Corps of Engineers[3]. The method takes a vast body of raw data and puts it in a form where it can be used easily and safely. The user of data in this form avoids the dangers inherent in the so-called "normals" of precipitation. The plan offers those in agriculture and allied pursuits a new tool to help them solve their problems.

REFERENCES

1 Finnell, H. H., 1944, Water Conservation in Great Plains Wheat Production. Texas Agricultural Experiment Station Bulletin No. 655 and unpublished data.

2 Hazen, Allen, 1930, Flood Flows. John Wiley & Sons.

3 U. S. Corps of Engineers, Engineering Construction, Flood Control Engineering School, Fort Belvoir, Va.

How Long "Chopped Hay"?

THE question is often raised as to how long "chopped hay" should be chopped. It seems that some research men and feeders are continually asking that the theoretical length be a little longer than is possible to cut it with present machines.

We hear rumors of chopped hay making the mouths of cattle sore, but as yet haven't heard of an authentic case. Dr. C. F. Huffman, dairy research specialist at M.S.C., says that sometimes cattle will have sore mouths when fed long hay or chopped hay, but that he never was sure what made their mouths sore. He is sure that chopping the hay wasn't the cause, because the ailment is not common to cattle being fed on chopped hay; in fact, it isn't common.

Agricultural engineers should help settle the question as to length for chopping hay. The manufacturers probably can build choppers for any desired length, but to keep changing it certainly adds to the cost of the chopper, which is eventually passed on to the user.—W. H. Sheldon, Michigan State College.

New Federal and State Bulletins

SEWAGE DISPOSAL SERVES RURAL SANITATION, by Robert G. White. Wyoming Agricultural Extension Circular 98 (January, 1948) (Laramie). Practical information on septic tank and related installations.

WHEN YOU BUILD OR REMODEL YOUR FARMHOUSE, by Deane G. Carter and Keith H. Hinchcliff. North Central Regional Publication No. 8. Illinois Extension Circular 620 (Urbana).

This is a contribution of the farmhouse subcommittee of the Regional Farm Structures Coordinating Committee. It indicates desirable features for farmhouses for the north central region, from Arkansas and Oklahoma to North Dakota and Ohio.

RESEARCH NOTES

A.S.A.E. members and friends are invited to supply, for publication under this heading, brief news notes and reports on research activities of special agricultural engineering interest, whether of federal or state agencies or of manufacturing and service organizations. This may include announcements of new projects, concise progress reports giving new and timely data, etc. Address: Editor, AGRICULTURAL ENGINEERING, St. Joseph, Mich.

USDA Notes on Performance Standards, Lightweight Aggregates, Wind Erosion Control, Rice Conditioning and Psychroenergetic Lab

By Jane Tuttrup

A UNIFORM basis for measuring the adequacy of building materials and construction methods is the objective of a new publication issued by the technical office of the Housing and Home Finance Agency, entitled "Performance Standards." The pamphlet proposes performance standards for such structural elements of the house as floors, walls, partitions, ceilings, and roofs, and presents data on insulation requirements.

Intended primarily for use by building officials, manufacturers, architects, engineers, testing laboratories, and others concerned with production aspects of housing, the publication emphasizes performance standards for materials and structural systems as an improvement on the common building code practice of stating requirements in terms of types, grades, dimensions, spacings, mixes, etc. The Agency states that this approach provides considerably more flexibility in the use of new materials and building techniques and is a needed step in the program of modernizing building codes to keep pace with progressive developments in dwelling construction.

Extensive research in engineering data and test reports is reflected in the report, which was prepared in consultation with other federal agencies, technical and engineering societies, trade associations, and professional engineers. The HHFA will welcome comments and suggestions for improving the requirements. It is expected that as the standards are applied under varying conditions additional knowledge will be forthcoming which will eventually lead to a nationally accepted set of performance standards.

Lightweight Aggregates. Another useful publication available from the HHFA is "Lightweight Aggregates for Concrete," the report of a survey begun in the fall of 1946 by the Construction Branch, National Housing Agency. The object of the survey was to gather specific reliable information on the newer and tested materials. The six types of aggregate investigated were expanded shale or clay (Haydite), expanded clay, pumice, diatomite, perlite, and vermiculite.

HHFA is sponsoring a special research and testing program on monolithic concrete utilizing lightweight aggregate materials. It is believed that the lack of reliable engineering data concerning such materials has limited their wider use in house construction. Cooperating in this work are the Bureau of Standards and the Bureau of Reclamation. Initially, samples from 24 producers of lightweight aggregates are being divided between the two facilities. Both bureaus will employ comparable laboratory procedures. Preliminary tests to determine density, strength, and insulation properties will be followed by structural tests, all aimed at developing engineering data which will make possible the application of rational analysis to lightweight concrete structures.

Wind-Erosion Control. Wind erosion specialists of the USDA Soil Conservation Service in the Great Plains have concluded after nearly two decades of study that soil blowing can be prevented in dry years, only if precautionary measures are used in the good years as well as in the dry years. At the top of the list is crop-residue management, or mulch culture. That means harvesting grain or other crops so as to leave adequate residue in the field and using it effectively as a surface protection to the soil.

Rice Conditioning. Agricultural engineers of the Bureau of Plant Industry, Soils, and Agricultural Engineering in cooperation with agricultural experiment stations in the rice-producing areas will initiate a study of better ways to dry and store rice. This is one of two projects covering research given top priority by the Rice Advisory Committee which have been approved under the Research and Marketing Act. The other project, directed by the Grain Branch of the Production and Marketing Administration, will develop new methods and standards for evaluating rouch rice to meet modern methods of production, handling, warehousing, processing, and marketing.

Better methods of drying or conditioning and storing rice are badly needed because of the increased use of combines in harvesting the crop. Combined rice usually contains more moisture than rice harvested under the older and separate operations of binding, shocking, and threshing. Combining has helped rice farmers handle their increased production and meet labor shortages. But better drying and storage facilities have not kept pace with the present-day harvesting procedures. Last year's U. S. rice crop was more than 71,000,000 bushels, with a farm value of $153,000,000. The 1936 - 40 five-year average was about 50,000,000 bushels, valued at $35,636,000.

Studies of requirements, methods and equipment for drying rice will include laboratory and field tests on methods and types of driers. Storage studies will check moisture content and temperature against rice deterioration and determine what types and sizes of storage are best for preserving quality of the grain, protecting against insects, and lessening labor.

The need for revision of rough rice standards also comes from the rapid shift to combine harvesting, to handling and storing rough rice in bulk rather than in bags, and to new methods of processing. The present rough rice standards are inadequate to meet modern methods of handling and marketing. Revised standards are needed to measure milling and other qualities at the time of warehousing or marketing. The plan is to develop a simple, rapid test of the milling yield and quality of each lot of rough rice and to develop a new set of standards that fit bulk handling and warehousing.

Psychroenergetic Laboratory. Representatives of the Missouri Agricultural Experiment Station and the Bureau of Plant Industry, Soils, and Agricultural Engineering held open house on March 11 at the new Psychroenergetic Laboratory, Columbia. The laboratory is now completed and in readiness for the first series of tests. The purpose of the conference was to acquaint interested research workers with the facilities available at Columbia for basic research on environment as it affects animal shelters and to obtain their suggestions for future research along both basic and practical lines. Although a considerable period of time will be required to determine the fundamental facts that govern design of shelters, it should be possible to start practical application studies at an early date and develop them along with the basic work, making appropriate changes as more basic information becomes available.

Initial objects of research at the laboratory are to discover the effects of environmental factors on the health, growth, and production of dairy cows; to determine the optimum environment for maximum production and what the producer must pay in terms of production for deviations from that optimum; and to measure the animal heat and moisture production at all levels of environment.

An explanation of the need for basic data on functional requirements was presented by Wallace Ashby, chief, division of farm buildings and rural housing, USDA. The physiological background and the elements considered in setting up first experiments were discussed by Samuel Brody, professor of dairy husbandry, University of Missouri. A. C. Ragsdale and H. A. Herman from the department of dairy husbandry at Missouri explained the selection of animals. Questions of environmental control in the laboratory and procedure in first experiments were discussed respectively by H. J. Thompson and J. R. McCalmont, USDA agricultural engineers. Inspection of the laboratory after luncheon was followed by a round table discussion led by W. G. Kaiser of the Portland Cement Association and participated in by representatives of the building materials and farm equipment industries, the A.S.A.E. advisory committee, and the agencies cooperating in the laboratory investigations.

New York Notes on Watering Poultry

By C. N. Turner

THE Hope-Flannigan Act has made it possible to conduct a study of water supply systems for the small poultryman. The study is a part of the poultry house equipment project being conducted at the New York State College of Agriculture, with the agricultural engineering and poultry husbandry departments cooperating.

The use of electric heating cable which was developed during the winter of 1943-44 has become very popular with the larger poultrymen. A 16-page bulletin is being published to help poultrymen make their existing systems automatic and protect them from freezing. However, the heating cable has its limitations and is not adapted to the small poultryman's problem. Therefore, the new study is aimed toward developing an automatic supply system for the small flock owner.

Five 20x20 ft houses of the Cornell shed roof design have been equipped with five different assemblies to provide the birds with water at the proper temperature at all times. Standard equipment and parts which could be readily obtained at low cost were employed in the various designs used. Each house has a frostproof pit for the supply pipe and waste water drain.

House A has a home-built bubbler cup installed on the vertical supply pipe in a 12-in vitrefied tile. No artificial heat is supplied because the water flows continuously bringing with it heat from the earth below the frost level.

House B has a drinking trough supplied by a ½-in pipe and automatic float valve. The pipe and valve are protected from freezing temperatures by means of a wood box about 7 in square. A 100-w screw-base cone heater and wafer thermostat located in the box maintain above freezing temperatures.

House C has the same type of supply and drinking trough as in B except that a thermostatically controlled solenoid valve allows water to flow and by-pass the float valve when the house temperature falls below 34 to 36 F. The wasted water collects *(Continued on page 178)*

NEWS SECTION

A.S.A.E. Annual Meeting Program

THE 1948 Annual Meeting of the American Society of Agricultural Engineers will be held at the Multnomah Hotel in Portland, Oregon, June 21 to 23. The meeting will actually get under way with the start of registration on the afternoon of Sunday, June 20, and with special entertainment, furnished by the committee on local arrangements headed by Clyde Walker, on Sunday evening.

There will be two general sessions during the meeting. The first one, on Monday afternoon, June 21, will include the President's Annual Address by George A. Rietz, manager, farm industry division, General Electric Co., and an address by H. B. Walker, professor of agricultural engineering, University of California, which will be in the nature of a resume of 16 years of sugar beet machinery research. Immediately following this, the annual business session of the Society will be held.

The second general session is scheduled for Wednesday forenoon, June 23, and will be devoted to keynote addresses on rural electrification, irrigation, and possibly farm structures.

The evening of June 23 will be given over to the Society's annual dinner, with Ivan D. Wood presiding as master of ceremonies.

POWER AND MACHINERY PROGRAM

The Society's Power and Machinery Division, under the chairmanship of Carlton L. Zink, head, tractor tire division, tire engineering department, Firestone Tire & Rubber Co., has arranged a program for three half-day sessions, two of which will be devoted exclusively to the general subject of the mechanization of sugar beet production.

The program for Monday forenoon, June 21, will open with a paper on the development of a new sugar beet harvester by J. B. Powers, University of California. This will be followed by a symposium on the present status of development of commercial sugar beet harvesters in which the following speakers will participate: J. L. Hipple, International Harvester Co.; V. F. Bozeman, John Deere Wagon Works; A. M. Jongeneel, and E. F. Blackwelder, Blackwelder Mfg. Co., and W. E. Nicholoy, Scott Viner Corp.

Another symposium — a review of the 1947 mechanical harvesting of sugar beets — will be a feature of this session, with Perc A. Reeve, Farmers' and Manufacturers' Beet Sugar Assn., presenting a review for the eastern area of the country, Rowland M. Cannon, Utah & Idaho Sugar Co., a review for the intermountain area, and Austin A. Armour, Spreckels Sugar Co., a review for the Pacific Coast area.

The second period of this program, scheduled for the forenoon of Tuesday, June 22, will open with a paper on the processing of sugar beet seed by Roy Bainer, University of California, which will be followed by a paper on the relation of planter development to sugar beet seedling emergence by W. S. McBirney, agricultural engineer, U. S. Department of Agriculture. R. D. Barmington, associate research engineer, Colorado A. & M. College, will present a paper on the relation of seed, cell size, and speed to beet planter performance. The final paper of this program will be on recent developments in control of weeds in sugar beets — a joint paper by W. W. Robbins and Roy Bainer, University of California.

The third half-day period of the power and machinery program will be mainly on the subject of weed control, opening with a joint paper by E. L. Barger and E. V. Collins of the Iowa Agricultural Experiment Station and R. A. Norton, USDA agricultural engineer, on engineering problems in the design of chemical weed control equipment. Following this, W. P. MacDonald, manager, agricultural department, F. H. Peavey & Co. will discuss some interesting developments of field spraying equipment for weed control in the spring wheat and flax-growing areas. Recent developments in equipment for the application of herbicides will be the subject of a paper by N. B. Akesson and W. A. Harvey of the California Agricultural Experiment Station. The program of this period will close with a report on the progress toward standardization of hydraulic controls for farm implements to be presented by E. W. Tanquary of the International Harvester Co.

RURAL ELECTRIC PROGRAM

The rural electric program for the first half-day — Monday forenoon, June 21 — arranged under the direction of Clarence J. Hurd, junior past-chairman of the Rural Electric Division, and owner, Hurd Farm Electric Supply, Spokane, Wash., will open with a paper on the development of automatic water systems for poultry in winter by C. N. Turner, Cornell University, and will be followed by a paper on a new single-phase electric motor for farm applications by B. P. Hess, Westinghouse Electric Corp. Myron G. Cropsey, Oregon State College, and June Roberts, State College of Washington, will present the results of research work at their respective institutions on poultry house floor heating. The closing number of this program will be a paper on new developments of poultry and dairy barn ventilation equipment by Nolan Mitchell, Aerovant Fan Co.

The second half day of the rural electric program, on Tuesday forenoon, June 22, will open with a paper on improved farm wiring materials by H. H. Watson, standards engineer, appliance and merchandising dept., General Electric Co. The contributions of commercial laboratories to farm electric equipment development will be discussed by T. K. Dimmitt, Puget Sound Power and Light Co., and possibly by other speakers. One or two other papers will also be provided for the program of this session.

The Rural Electric Division will collaborate with the Soil and Water Division on a joint program on spray irrigation for the forenoon period on Wednesday, June 23.

SOIL AND WATER PROGRAM

Ralph C. Hay and Aldert Molenaar, respectively chairman and vice-chairman of the Soil and Water Division, are arranging the program for three half-day periods which will give special attention to soil and water problems and achievements in the western part of the country, particularly of the Pacific Northwest. The opening program on Monday forenoon, June 21, will start off with a paper on the use of snow survey data for agricultural planning by R. A. Work, U. S. Soil Conservation Service. It is expected that a paper on drainage of irrigated lands will be presented at this session by a representative of the USDI Bureau of Reclamation. Two papers on water spreading, one in California and the other in North Dakota with farm equipment, have been tentatively scheduled for this session.

The second half day of the soil and water program, on Tuesday, June 22, will include a paper on permeability measurement procedure by R. K. Frevert, Iowa State College, and a paper on concrete drain tile by D. G. Miller, U. S. Public Roads Administration. Two other papers are being arranged for this period.

The program for the third period, on Wednesday, June 23 — a joint program with the Rural Electric Division — will be devoted exclusively to the general subject of sprinkler irrigation. Arrangements are now in progress for several speakers to contribute to this program.

FARM STRUCTURES PROGRAM

The Farm Structures Division, under the chairmanship of Henry Giese, professor of agricultural engineering, Iowa State College, is arranging a program for three half-day periods, on June 21, 22, and 23, which will include all or most of the following subjects: Prefabrication of small buildings, results of five-year tests in spray painting of farm metal roofs, environmental requirements for swine, housing problems in the Columbia Basin area, farm structures problems in Alaska, farm buildings in other countries, graphs for use in rapid calculation of stresses in grain bins, and regional research in the selection and utilization of materials for farm building construction. Other possible subjects to be included in the farm structures program are remodeling needs in farm structures, a survey of pen milking barns, the REA farm sanitation program, recent developments in the manufacture and use of precast concrete septic tanks, and application of the tilt-up method of concrete construction for farm buildings.

COLLEGE DIVISION PROGRAM

The College Division, under the chairmanship of A. J. Schwantes, chairman, agricultural engineering division, University of Minnesota, is planning a one-half-day session during the *(Continued on page 170)*

A.S.A.E. Meetings Calendar

April 16-18—GEORGIA SECTION, Myers Lodge, St. Marks, Fla.

April 23-24 — PENNSYLVANIA SECTION, Ag Engineering Bldg., Pennsylvania State College, State College.

April 29 to May 1 — MISSOURI SECTION, Hotel Muehlebach, Kansas City, Mo.

May 3 — CHICAGO SECTION, Builders' Club, Chicago.

May 6 — MICHIGAN AREA SECTION, Michigan State College, East Lansing.

May 14-15 — VIRGINIA SECTION, Hotel Roanoke, Roanoke, Va.

June 21 to 24 — ANNUAL MEETING, Multnomah Hotel, Portland, Oregon.

September 8-10 — NORTH ATLANTIC SECTION, Ontario Agricultural College, Guelph, Ont., Canada.

October 21 and 22 — PACIFIC NORTHWEST SECTION, Columbia Gorge Hotel, Hood River, Ore.

December 13-15 — WINTER MEETING, Stevens Hotel, Chicago.

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NEWS SECTION

(Continued from page 168)

meeting which will deal largely with power and machinery subject matter in the professional agricultural engineering curriculum, and which will cover such phases as teaching objectives, subject matter to be taught, related courses from other departments, number of courses in the curriculum, course and sequence, and methods of teaching the various courses.

A program of particular interest to members of A.S.A.E. Student Branches and Student Members of A S.A.E. is now being arranged by the Committee on Student Branches headed by F. W. Peikert, professor of agricultural engineering, Michigan State College, in collaboration with officers of the National Council of A.S.A.E. Student Branches. It is planned for this program to be in three and possibly four parts.

It is expected that copies of the program in printed form will be available shortly after May 1, and will thereupon be mailed to members of the Society. Others interested may obtain copies by writing to A.S.A E. headquarters, St. Joseph, Michigan.

A.S.A.E. Officers for 1948-49

AS A result of the regular election of officers of the American Society of Agricultural Engineers conducted recently by letter ballot, the following have been elected and will take office at the close of the Society's annual meeting to be held at Portland, Oregon, in June.

President— Arthur J. Schwantes, chief, agricultural engineering division, University of Minnesota.

Councilors (3-year term each) — C. J. Scranton, chief engineer, harvester division, Allis-Chalmers Mfg. Co., and D. G. Carter, professor of farm structures, University of Illinois.

The new Council of the Society for the year 1948-49 will include the above-named officers together with the following: M. L. Nichols and G. A. Rietz, past-presidents; C. N. Hinkle, P. T. Montfort, E. D. Anderson, and W. W. Weir, councilors.

The newly elected Nominating Committee of the Society consists of J. P. Fairbank (chairman), G. B. Nutt, and B. G. Van Zee. Members of the Society are invited to send any member of the Nominating Committee such suggestions as they may have for nominees for the elective offices of the Society in the next annual election of officers, to be held early in 1949. It is desirable that such suggestions be made on or before June 1, 1948.

A.S.A.E. Three-State Section to Organize

AT A meeting of the Missouri Section of the American Society of Agricultural Engineers to be held at the Hotel Muehlebach, Kansas City, Mo., April 29 to May 1, the organization of a three-state section, comprising Kansas, Nebraska, and Missouri, will be effected, whereupon the Missouri Section will be dissolved.

The program was planned to be of interest to agricultural engineers in all three states, and will open with a dinner at 6:30 p.m., April 29, with Howard E. Everett, editor and manager of "Implement and Tractor," as master of ceremonies. The principal feature of the dinner will be an address by A.S.A.E. President Geo. A. Rietz, manager, farm industry division, General Electric Co., who will speak on opportunities for agricultural engineers.

The program for the forenoon session of April 30 will open with a panel discussion of the subject of training 4-H club leaders in machinery maintenance. C. N. Hinkle, agricultural engineer, Standard Oil Co. of Indiana, will discuss the place of the manufacturers in such a training program, and R. S. Clough, 4-H club leader for Missouri, will talk on the value of such training. Following discussion from the floor, the subject will be summarized by John M. Ferguson, Kansas State College.

Three papers will conclude the program of this session — one on evaluating soil losses from field areas, by D. D. Smith of the U. S. Soil Conservation Service, another on upstream flood control by Austin W. Zingg, also of the SCS, and a third by H. J. Thompson, USDA agricultural engineer, on the new psychroenergetic laboratory at Columbia, Mo., for making studies of farm building requirements.

Missouri Section Secretary Paul N. Doll will preside at a special luncheon on April 30, on which occasion considerations in organizing a three-state section of the Society to replace the present Missouri Section will be discussed by A.S.A.E. National Secretary Raymond Olney.

The afternoon of April 29 will be given over to a tour of the Fairfax industrial district in Kansas City, and the Section business meeting will be held at the Hotel Muehlebach in the evening.

The forenoon session on May 1 will open with a panel discussion on important research problems in the three-state area — Kansas, Nebraska, and Missouri — of particular interest to agricultural engineers. The speakers will be F. C. Fenton, Kansas State College, who will outline research problems in his state; K. B. Huff, University of Missouri, who will discuss research problems in Missouri, and C. W. Smith, University of Nebraska, who will review matters of research interest in that state. Following discussions from the floor, a summary of the discussions will be made by J. C. Wooley, University of Missouri.

The concluding number of the program will be an address by Dr. C. L. Schrewsbury, chairman of agricultural chemistry research at the Midwest Research Institute in Kansas City, who will discuss the work of the Institute in relation to research in the agricultural experiment stations in the three-state area.

Officers of the Missouri Section extend a cordial invitation to all A.S.A.E. members and others interested in the program to attend the meeting in Kansas City, and they suggest that those who plan to attend make their hotel reservations early by writing Miss Gladys Blanck, reservation manager, Hotel Muehlebach, Kansas City, Mo.

Copies of the program and other information about the meeting may be obtained from Paul N. Doll, P. O. Box 355, Jefferson City, Mo., or from the A.S.A.E. headquarters office at St. Joseph, Mich.

Schaller New Chairman Minnesota Section

THE Minnesota Section of the American Society of Agricultural Engineers at its annual dinner meeting held March 4, in the Coffman Memorial Union at the University of Minnesota, elected John H. Schaller, advertising manager, Rilco Laminated Products, Inc., and formerly head, research section, agricultural engineering development division, Tennessee Valley Authority, as the new chairman of the Section for the ensuing year. Also elected were vice-chairman, Martin Ronning, chief engineer, power machinery division, Minneapolis-Moline Power Implement Co., and secretary-treasurer, Marvin Nabben, agricultural engineer, Northern States Power Co. The Section's new nomination committee for the year consists of D. G. Miller (chairman), P. W. Manson, and B. G. Van Zee.

More than 50 members and friends of the Section attended the dinner, the outstanding feature of which was an address by A.S.A.E. President, George A. Rietz. Ronald A. Glaze, chief engineer, Weyerhaeuser Sales Co., presided as master of ceremonies at the dinner.

Pennsylvania Section Program

THE Pennsylvania Section of the American Society of Agricultural Engineers is offering a most attractive program for its coming meeting to be held April 23 and 24, in the Agricultural Engineering Building, Pennsylvania State College, State College.

The first session of the meeting, on the afternoon of Friday, April 23, will open with a talk on farm structures, with particular reference to the Better Farm Buildings Association, by J. F. Schaffhausen, vice-chairman, A.S.A.E. Farm Structures Division, and manager, farm markets division, Johns-Manville Corp. F. Oliver, Pennsylvania Power and Light Co., will present a paper on corn drying, and L. S. Singley of West Penn Power Co., a paper on grain drying. A field method of moisture determination will be discussed by H. V. Walton, Penn State ag engineer. R. E. Wineland, also of the Penn State ag engineering staff, will talk on hay crushers and forage choppers. A paper on weed control by S. M. Raleigh of the Penn State agronomy department will close the program for the session.

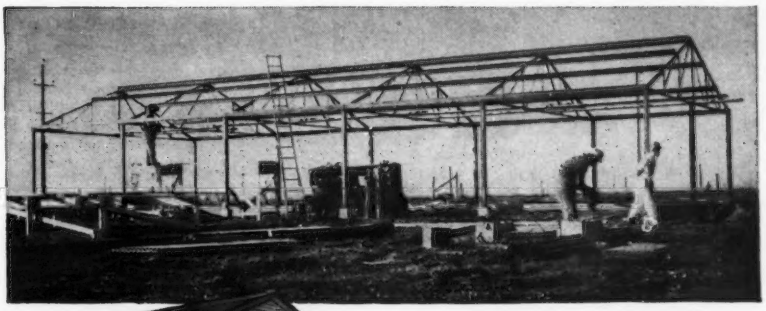
D. C. Sprague, of the Penn State ag engineering staff, will preside at a dinner meeting on April 23. At this meeting, Paul Margolf of the Penn State poultry department will discuss new methods of marketing poultry, following which motion pictures presenting new developments in farm machinery will be shown. The remainder of the evening will be given over to two round tables, one on power and machinery to be directed by C. H. Bingham of Penn State ag engineering extension, and the other on rural electrification directed by Stanley Bidlack, farm applications engineer of the Philadelphia Electric Co.

The theme of the session on the forenoon of Saturday, April 24, will be tillage requirements of field and vegetable crops, and will open with a talk by F. G. Merkle of the Penn State agronomy department on tillage and soil relationships, followed by one on tillage requirements for vegetable crops by M. L. Odland of the horticulture department of the same institution. W. W. Tranter, engineer, A. B. Farquhar Co., will discuss tillage requirements for potatoes, and Harold Kellett, a vegetable grower near Philadelphia will report on his tillage experiences. A. W. Clyde, Penn State ag engineer will present a paper on safety stop hitches, followed by a report on tillage experiments by R. E. Patterson, also of the Penn State ag engineering staff. J. B. R. Dickey of the Penn State agronomy extension service will close the program with a talk on the practical aspects of tillage.

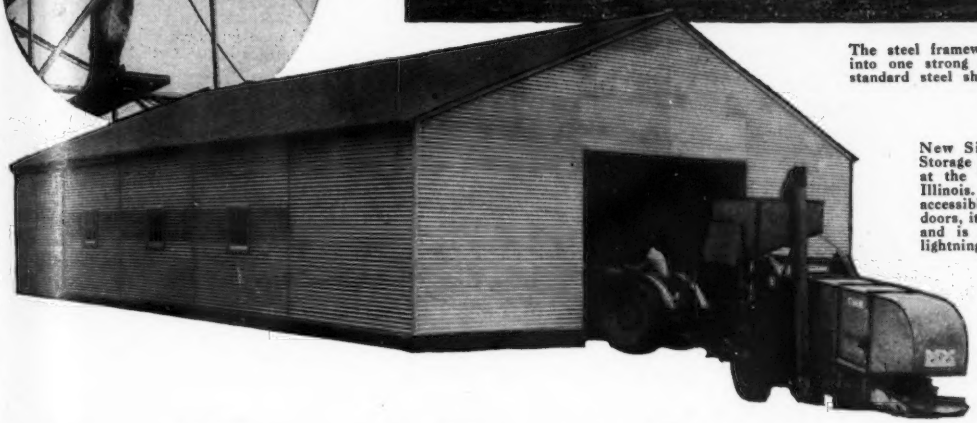
Turner Heads National Fertilizer Committee

AT ITS business session in Chicago last December the National Joint Committee on Fertilizer Application elected as its new chairman, Arthur W. Turner, assistant chief, USDA Bureau of Plant Industry, Soils and Agricultural Engineering, in charge of agricultural engineering research. The National Joint Committee is comprised of representatives of the American Society of Agronomy, American Society for Horticultural Science, National Fertilizer Association, Farm Equipment Institute, and the American Society of Agricultural Engineers. Mr. Turner is a past-president of A.S.A.E.

Welding the ridge purlin to the trusses. All structural steel is delivered to the job pre-cut to length at the warehouse.



The steel framework is welded together into one strong unit. All members are standard steel shapes.



New Site Welded Machinery Storage Building, 36′ x 60′ x 10′, at the Whiting Farm, Ludlow, Illinois. This building is very accessible because of the spacious doors, it has excellent appearance and is resistant to wind, fire, lightning and weather.

New Type of Steel Construction

LEADS THE WAY TO IMPROVED FARM BUILDINGS

U·S·S *Site Welded* Steel Frame Buildings are a big step forward in the design of efficient, high quality farm buildings.

Farmers, agricultural college professors, and Carnegie-Illinois Steel Corporation engineers have worked together to perfect designs for farm buildings constructed of steel. These structures are "*Functionally Designed*" to meet farm needs. The supporting steel frames of these buildings can be fabricated and assembled on the site by welding, thereby obtaining the economical and positive character of rigid construction.

Site welded buildings are designed in standard sizes 24′ x 60′ and 36′ x 60′, with lengths variable in multiples of 12′. They are roofed and sided with 24 gage corrugated galvanized steel sheets. The sheets are securely attached to the steel frame by self-tapping, plated cap screws with a soft lead washer against the sheet and a steel washer under the head of the screw. Between steel columns the sidewall sheets are nailed to intermediate wood studding. These buildings are constructed of steel, wood and concrete, with each material functionally utilized to furnish the buyer the most for his money.

Site welded construction can be used for most farm buildings. However, it must be remembered that this is a new development and materials are as yet available only in limited quantities.

Last year, approximately 60 U·S·S Site Welded Buildings were constructed, demonstrating the practicability and serviceability of this type of construction. For information write to Agricultural Extension Bureau, Carnegie-Illinois Steel Corporation, Room 2019 Carnegie Building, Pittsburgh 30, Pa.

CARNEGIE-ILLINOIS STEEL CORPORATION · USS · SITE-WELDED STEEL FRAME BUILDINGS · UNITED STATES STEEL

CARNEGIE-ILLINOIS STEEL CORPORATION

Pittsburgh, Pa.

United States Steel Supply Company
Warehouse Distributors, *Coast to Coast*
United States Steel Export Company, *New York*

8-571

UNITED STATES STEEL

HELPING THE AMERICAN FARMER DO A *BETTER* JOB

SISALKRAFT "CASE HISTORIES" OVER A PERIOD OF 20 YEARS IN THE FIELD OF PRACTICAL RESEARCH

SISALKRAFT SILOS:

It was back in the late '20s . . . on a farm in the dairy belt . . . snow-fence lined with SISALKRAFT was used to form walls for a temporary silo. Filled with silage, it looked like a practical idea . . . but the SISALKRAFT (as it then was made) was rotted through by silage acids.

SISALKRAFT researchers analyzed the cause of this failure . . . soon developed an acid-resisting SISALKRAFT that solved the major part of the problem . . . engineered some simple, improved adaptations of the SISALKRAFT-lined snow-fence for silos . . . and started the movement that has since resulted in hundreds of thousands of successful SISALKRAFT silos throughout the past two decades. Last year, at very low cost, farmers built more than 50,000 such silos, in capacities of 20 to 200 tons . . . thus saving untold tons of silage that might have been wasted.

SISALKRAFT Practical Research has been continuous . . . aiming always to help the American Farmer do a better job, economically . . . as evidenced by many similar achievements of SISALKRAFT on the farm.

Should you have a problem where a remarkably strong, waterproof paper might be helpful, please write to

Dept. A.E.

The SISALKRAFT Co.

205 W. Wacker Drive, Chicago 6, Ill.

SISALKRAFT Products are sold by Lumber Dealers throughout America.

Henderson New Southwest Section Chairman

A TOTAL of approximately 100 members and friends of the Southwest Section of the American Society of Agricultural Engineers, comprising the states of Texas, Louisiana, Oklahoma, and Arkansas, gathered at the meeting of the Section held at Texarkana, Texas, March 26 and 27. At the business session of this meeting R. H. S. Henderson, assistant manager of the Dallas branch, Allis-Chalmers Mfg. Co., was elected chairman of the Section for the ensuing year, succeeding Kyle Engler.

Harold T. Barr, head of agricultural engineering research, Louisiana State University, was elected vice-chairman, following a term as secretary-treasurer of the Section, and Ross R. Mauney, agricultural engineer, Arkansas Power and Light Co., was elected the new secretary-treasurer of the Section.

One of the features of this year's meeting was the activity of agricultural engineering students who are pursuing agricultural engineering curriculums in the land-grant colleges in the Section area.

Personals of A.S.A.E. Members

Elmer R. Daniel has resigned his position as household engineer, agricultural engineering division, Tennessee Valley Authority, and is now employed as rural electrification specialist with the Oklahoma Agricultural Extension Service, under cooperative contract with the USDA Extension Service and Rural Electrification Administration.

Arthur Huntington, past-president of A.S.A.E., and public relations engineer and economist, Iowa Electric Light and Power Co., recently received from Ohio State University the belated award of a Varsity sweater for his service with the University football team during the season of 1895.

A New Barn-Wiring Cable

TO THE EDITOR:

I AM sending you a sample of a brand new type of barn-wiring cable constructed such as I had hoped to be able to obtain at some future time. You will note that the copper is insulated with 1/32 in of type R rubber, over which is extruded 1/64 in of neoprene. The two conductors are then paralleled and covered with a 1/32-in jacket of neoprene. Both dielectric value and impact resistance are much greater for this new construction than is common to any ordinary non-metallic sheathed cable. The resistance of neoprene to exposure to acids, moisture, and sunlight is common knowledge.

The cost of this new wiring material (trade name "RoBARN") to the contractor will be, approximately, only $15 per 1000 ft above the cost of the lowest-priced non-metallic sheathed cable now available. Inasmuch as the average barn in this area (Minnesota and the Dakotas), apparently requires from 250 to 500 ft of wire, the actual cost per barn for cable, which should last indefinitely, over and above the cost of the non-metallic sheathed cable which must be replaced in from two to six years, would not be more than $7 or so.

The Rome Cable Corp., producers of this new wiring material, have agreed to make a continuous run which will last until present jobbers have ample stocks.

Since the A.S.A.E. winter meeting at Chicago last December, at which I presented the paper, entitled "The Case Against Non-Metallic Sheathed Cable," (see AGRICULTURAL ENGINEERING for February, 1948, page 55), I have been besieged by engineers from many mills, and no doubt there will be other companies soon producing barn-wiring material similar to the sample I am sending you.

GLENN ROWELL

Engineer
Fire Underwriters Inspection Bureau
Minneapolis, Minnesota

An Agricultural Engineer's Day in India

TO THE EDITOR:

MANY and varied are the problems to be considered daily by an agricultural engineer in a city like Calcutta. Some extracts from the daily program of an agricultural engineer may make strange and partially amusing reading. He is mainly concerned with the farm machinery field. To the sales agent, to the representative engineer, and to the average tractor mechanic and driver of whose vocation is concerned with tractors and other farm machinery.

I should give some indication of his duties in his present capacity. For an engineering concern, and especially in a commercial firm, the basic purpose of his position is to organize and to administer fairly large diesel and kerosene engineering business for sales. This of course entails full representation of an American manufacturer, like International Harvester, Caterpillar, etc.

A brief summary of his duties during the day in a single week will give a clear idea of the varied ranges of work which he anyhow or other manages to tackle.

He generally commences the day by clearing the past day's mail. One will see on his table a pile of letters *(Continued on page 174)*

Applies FERTILIZER as he CULTIVATES

THIS RANCHER DOES TWO JOBS IN ONE –

Milo Ferini and D. Ardantz, keen ranchers of Santa Maria, California, hit on the happy idea of adapting a fertilizer distributor to their cultivator tractor; thus, one man is able to do two jobs at once.

The "cultivator-fertilizer" can cover 30 acres in a 10-hour day! It costs about $290 to make. Mr. Ferini and Mr. Ardantz have found that it pays to farm with Texaco Products. And they like the service they get from Texaco Man K. E. Trefts and his driver, J. F. Draper.

Mr. D. Ardantz points to two old auto transmissions on fertilizer attachment that permit 9 rates of distribution speed. In foreground is Texaco Marfak, the lubricant that sticks to bearings longer and gives better lubrication protection.

Tune-up time: Mr. George C. Strong, successful potato farmer of Long Island, N. Y., applies Marfak to his grain drill as popular Texaco Man Q. C. Hurdle looks on. Mr. Strong finds it pays to use Marfak lubricant because it sticks to the job and resists wash-out, jar-out, squeeze-out and dry-out.

It's a friendly "deal" — doing business with Texaco. L. A. Millican, Texaco Man, chats with Mr. John O. Stoneham, prominent farmer of Navasota, Texas, while his driver, John Engelke, delivers Fire-Chief, the gasoline with superior *"Fire-Power."*

THE TEXAS COMPANY

TEXACO
REG. T.M.

Tune in: TEXACO STAR THEATER every Wednesday night featuring Gordon MacRae, Alan Young, Evelyn Knight. See newspaper for time and station.

IT PAYS TO FARM WITH TEXACO PRODUCTS

DIVISION OFFICES: Atlanta 1, Ga.; Boston 17, Mass.; Buffalo 3, N. Y.; Butte, Mont.; Chicago 4, Ill.; Dallas 2, Tex.; Denver 1, Colo.; Houston 1, Tex.; Indianapolis 1, Ind.; Los Angeles 15, Calif.; Minneapolis 2, Minn.; New Orleans 6, La.; New York 17, N. Y.; Norfolk 1, Va.; Seattle 11, Wash.
Texaco Products also distributed by McColl-Frontenac Oil Company, Limited, Montreal, Canada

Ag Engineer's Day in India

(Continued from page 172)

and a few telegrams always awaiting his action. Generally asking supply of a machine or some spare parts from ready stock. Several wanting suggestions for the improvement of farm and undertakes of various schemes, asking quotations and ensuring satisfaction for the future service. He generally gets 3 to 4 mails a day, and tell you frankly every mail brings him a severe headache and new problems. Particularly the morning mail is a nuisance.

Enquiries for new tractors and engines mean dictating full specifications for immediate dispatch. Most of the time you will see him busy with his steno dictating replies of the letters. Meanwhile, he gets a ring and you will see him hurriedly referring to files or turning the pages of his folder as he has to give definite information then and there on the phone. He has not yet finished, and the bearer appears with some visiting cards. Thinking that the next few minutes will be spent in discussion, he puts the matter in abeyance of dictating letters and directs his steno to go, and simultaneously shooks his head towards the bearer to call the men in. He puts up the receiver and shakes hand with the fellows and greets them with a smile on his face. Here he meets all sorts of men—farmers, engineers, contractors—and tries his utmost to tackle the job and see that they go happy and satisfied.

He looks at the clock; it is one. Ah! time for launch. He thinks that he will get some rest. In the meantime, he gets a ring from service station; mechanics are unable to understand the complicated machine. Off he goes in a taxi to service station. After few minutes you see him busy with a wrench and a hammer in his hand explaining and assembling the machine.

"Sahib, telephone," shouts cooli; he puts the tools and hurriedly runs to the phone. His boss is calling him in the office; he leaves that job unfinished and returns. There he meets his clients and faces the usual complaint for spares and delivery date problem. Now you will find him giving excuse and putting blame on the suppliers of the equipment; anyhow he satisfies his clients.

In the mail he gets a letter which invites him to see the farm conditions. At once, he goes to his boss and arranges his going. He really loves country sides and farm life and gets relief for a day or two.

Never I believe one will have a more interesting position.

Assistant agricultural engineer,
Volkart Brothers, Calcutta, India.

R. P. SAXENA.

American Ag Engineers Visit West China

TO THE EDITOR:

DURING the month of December, 1947, the Committee on Agricultural Engineering consisting of E. L. Hansen, H. F. McColly, Archie A. Stone, and the writer, and now serving with the National Agricultural Research Bureau of China visited Szechwan Province in West China. The Committee flew to Chungking from Nanking and traveled on to Chengtu then farther north by a light truck. Chungking was the wartime capital of China, while Chengtu was a capital of the country centuries ago, and during the war was the seat of many displaced colleges and universities. The ten-day trip back from Chungking was by a river steamboat down the Yangtze River, through the gorges, a thrilling experience, to say the least.

Szechwan Province is not as large as Texas, but it is larger than California. There we found a highly developed manual type of agriculture, subtropical in character. The principal crop is rice, but a wide variety of crops including fruits are grown. The fruits included berries, oranges, bananas and apples. Szechwan is an area which produces an agricultural surplus. Its products would go a long way toward taking care of China's food deficiencies if adequate transportation were available. Here agriculture has continued with little apparent change for centuries. Many interesting observations might be described, but the trip to the Tukiangyien irrigation system was of particular interest to the Committee and may be to our friends.

The Tukiangyien irrigation system is located north of Chengtu, and we traveled by bus through the irrigated area to the headwaters of the two large canals into which the water of the Meankiang River is diverted. After inspecting the canals and the temple erected in honor of Li-Ping the governor who with his son built the early works, we were carried in sedan chairs over the mountains to see the diversion dam.

The system is 2200 years old, having been built about 250 B.C., and it has continued down through the years without much change except for some expansion. The two main canals now water more than 500,000 acres of some of the world's most productive land.

The irrigation works consist primarily of a diversion dam for dividing and directing the flow of the Meankiang River. These dams are of an original type of construction and are rebuilt every year. The base of the dams are made of wooden tripods *(Continued on page 176)*

DESIGN BETTER FARM HOMES *with* CONCRETE

AS agricultural engineers well know, thousands of American farms need new homes that meet modern standards of comfort, convenience and firesafety.

Concrete's firesafety makes it the logical farm home building material. Its moderate first cost, low upkeep and lifetime service also make it a wise investment.

Then too, concrete homes are weathertight —warm in winter, cool in summer and clean and dry the year around. Concrete homes can be built in any size or architectural style—on any floor plan.

Any home is a better home when built of concrete.

ILLUSTRATED BOOKLET FREE Write today for a free copy of a new 32-page booklet—"Building Better Farm Homes with Concrete." Distributed only in the United States and Canada.

PORTLAND CEMENT ASSOCIATION

Dept. 4-1 33 WEST GRAND AVENUE, CHICAGO, 10, ILLINOIS

A national organization to improve and extend the uses of portland cement and concrete

. . . through scientific research and engineering field work

Roll call for the battle against farm rust

First to answer is ARMCO ZINCGRIP. The coils of this special-purpose steel pictured above will be formed by leading manufacturers into stock tanks, poultry equipment and parts for combines, corn pickers and other farm machinery and equipment — to wage a stubborn fight against rust.

Manufacturers of farm equipment like ARMCO ZINCGRIP because its tough zinc coating doesn't break or peel in even the severest manufacturing operations. This assures complete rust protection. Years of testing under all kinds of atmospheric conditions show the special zinc coating of ZINCGRIP lasts 15 to 45 per cent longer than regular galvanized coatings. Even in stock tanks, in constant contact with water, ZINCGRIP has proved its exceptional durability.

The farmer's machinery and equipment cost less when made of ZINCGRIP because they serve him years longer. He has fewer replacements and repairs, less lost time because of laid-up machinery.

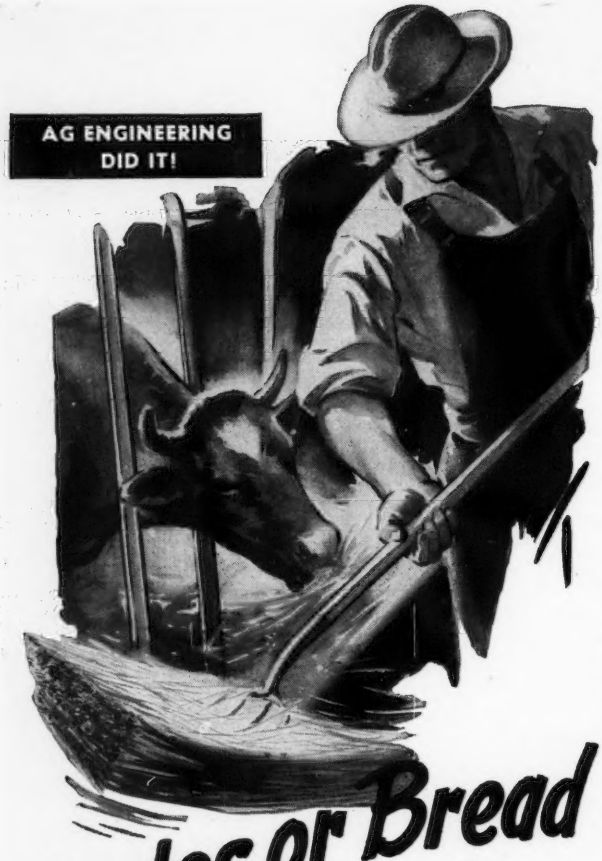
ZINCGRIP is typical of the many special-purpose steels perfected by Armco to help manufacturers build better products for the farm. Each was developed to give longer service in a particular product or type of use. Alert farmers know that the famous Armco triangle means *extra* quality in steel. That's why they look for it when they buy. The American Rolling Mill Company, 96 Curtis Street, Middletown, Ohio. Export: The Armco International Corporation.

TURN IN YOUR SCRAP NOW—*Help make more steel*

Scrap piles in most steel mills are critically low. Unless this shortage is relieved, everybody must wait longer for steel. You can help. Check your unusable tools, machines, and obsolete equipment. Collect all the steel scrap you can find and speed it through regular channels to the mills. Remember—*more scrap means more steel, sooner.*

ARMCO

ZINCGRIP STEEL



Bales or Bread

SLICING MAKES FEEDING EASIER

Applying engineering principles to the farmer's needs, Agricultural Engineers developed the "Sliced Bale". Like bread, hay handles easier if sliced. Feeding it, slice by slice, the rest of the bale stays tight and tidy. No pulling and tugging to feed every forkful. Any farmer who ever fed an unsliced bale knows what that means. And he's grateful to the Ag Engineer for placing knives where they'll cut with every stroke of the plunger. Each bale has a plus benefit . . . clean cut slices.

For benefits like these, the credit goes to Ag Engineers. First, they understand the need of the farmer feeder. Then, from their drafting boards . . . right on through field testing to production . . . comes the part that fulfills this need. In this case, clean-cutting knives to give clean-feeding bales.

NEW HOLLAND MACHINE COMPANY
NEW HOLLAND, PENNSYLVANIA

NEW HOLLAND
FARM ENGINEERED MACHINERY FOR BETTER FARMING

Ag Engineers Visit West China

(Continued from page 174)

covered with bamboo mats which are plastered with mud on the upstream side.

The weirs for controlling the head of water are made, for the most part, of bamboo cages filled with stones referred to as "sausages". Every year the works need to be partly rebuilt or repaired, and a certain amount of excavation is necessary to guide the river flow.

A visitor cannot help being greatly impressed with the extent of the system as well as its age. The fact that the works are not more permanent causes most engineers to ponder about the advisability of a different type of construction. The visitors are shown a model illustrating how it is hoped to change and expand this most interesting and ancient example of irrigation works.

Nanking, China — J. B. DAVIDSON

Turner Reviews Research for Canning Industry

"THE Status of Agricultural Engineering Research" was the subject of an address, January 20, before the Raw Products Conference of the National Canners Association convention at Atlantic City, N. J., by Arthur W. Turner, assistant chief, in charge of agricultural engineering research, Bureau of Plant Industry, Soils, and Agricultural Engineering, U. S. Department of Agriculture. A few highlights from his presentation of agricultural engineering as a factor in the cost and quality of farm products for commercial canning follow:

"Engineering has done much for the factory side of the food-canning industry just as it has for all manufacturing, transportation, communications, and construction. It can do just as much in field operations on the crops that the canning industry processes.

"The objectives of engineering applications and research in agriculture may be summed up as (1) precision planting of high-quality seed and seed stock, (2) full product recovery through efficient harvesting, and (3) quality control through proper methods of production, storage and handling.

"Agricultural research, both state and federal, is largely public service research. Public service research is directed first of all toward solution of basic or fundamental problems. The problems of basic research in engineering are those that are common to a group of producers or groups of manufacturers. It is the job of public service research to develop the basic data. Once this is available, producers and industry apply it through individual practice or industrial developments.

"Applications of engineering in crop production, harvesting, and processing are tending to eliminate weather hazards. Controlled mechanical planting, use of new methods of weed control through flame and chemicals, and development of drying or conditioning facilities are giving the producer the means for planning his season's operations with greater skill than ever before.

"At this time there are many important questions under consideration in agricultural engineering research. Here are just a few of them:

"What crop-conditioning requirements and facilities does the producer need so he can hold and market his commodities in top quality condition at his own convenience rather than to sell them on a flooded market at harvest time? This question opens up a whole field of engineering research that is relatively unexplored.

"Can tobacco, cotton, peanuts, sweet potatoes, and in fact all vegetable crops, be mechanized for quantity production and quality control? On many of these products the surface of the research that needs to be done has barely been scratched.

"How much does the producer pay for inefficiency in farm processing plants and small industries handling farm products, and what can engineering do to reduce costs? Output per worker varies as much as 25 per cent in creameries within boundaries of a county, 800 per cent in milk marketing, and 65 per cent in poultry processing plants.

"Can the potentiometer be used to supplant the seed germination test as a means for determining seed viability and growth characteristics? Some experiments have shown rather startling results and indicate this instrument may have untold value to the plant breeder.

"You may be interested now in what agricultural engineers in the Department of Agriculture are doing and where.

"The Farm Machinery Division is organized to the following pattern: The commodity group, which we call "vertical," makes studies leading to the development of specialized crop production and harvesting machinery for peanuts, tung nuts, sweet potatoes, sugar cane, sugar beets, and cotton.

"The horizontal phase is according to operations — pest and plant disease control machinery, fertilizer placement, tillage machinery investigation, and weed control machinery. These obviously cut across all crops.

"Earlier I indicated that our work was cooperative with the state agricultural experiment stations. To list all the projects and accomplishments would be a lengthy procedure. So I will list only some of the recent developments to which federal agricultural engineers have made important contributions:

"Sweet potatoes: New bed cultivators, disk-type transplanter, vine removers, sweet potato digger. *(Continued on page 178)*

Jamesway

TRADE MARK REG.

cuts my daily chore time . . .

1½ HOURS

says Walter Unverfehrt, Hoyleton, Illinois

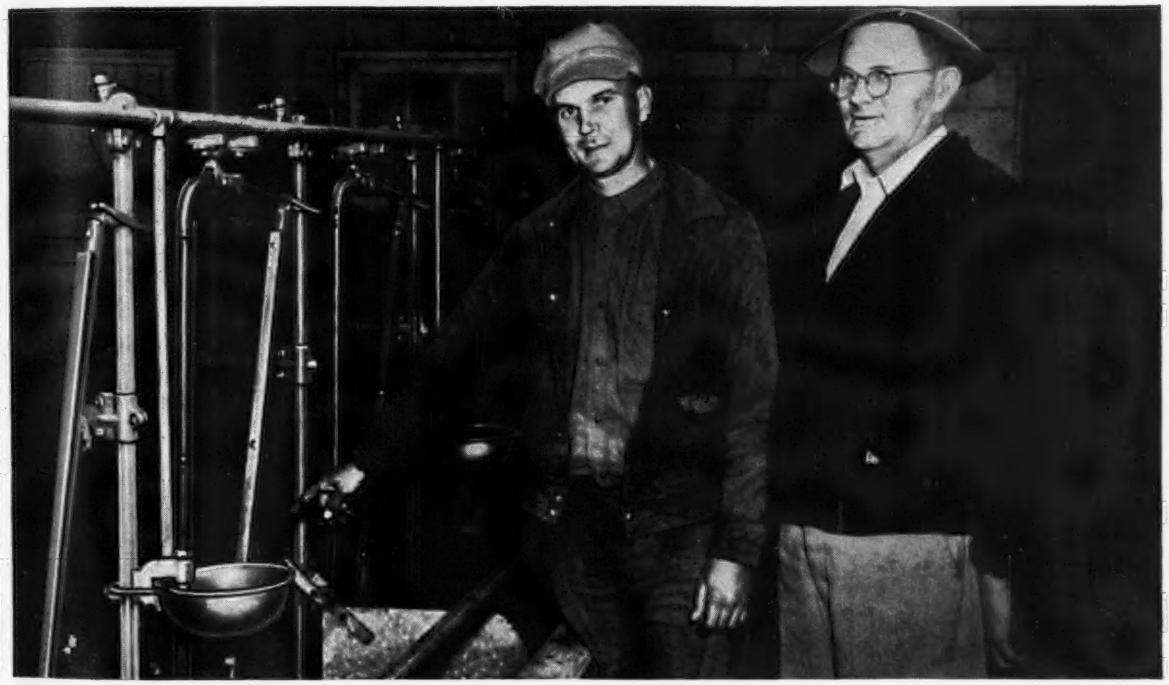
Yes! Out the window went 1½ hours of hard, tiresome, *unnecessary* work. In its place, Mr. Unverfehrt gained 1½ hours of *freedom* — extra time for other chores and other profit opportunities.

"My Jamesway water cups alone save me an hour a day," he says, "and my Jamesway stanchions and stalls save another half hour. Add that up for one year and I save nearly 30 days of choretime!

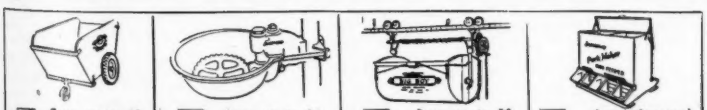
"Greater ease of handling my herd of 20 Holsteins means a big saving in work. So does easier barn cleaning. Water cups not only save steps, but have increased my monthly milk check 10%!"

What Mr. Unverfehrt has done, you can do too — at surprisingly low cost. Modernize your barn now! Your Jamesway dealer will be glad to show you how Jamesway plans and equipment can turn *your* time into *extra* profit!

While Jamesway dealer, Paul Fark, looks on, Mr. Unverfehrt (left) points to his Jamesway water cups which have boosted milk production 10%.



✓ Check this Jamesway Chart to See How Much Time You Can Save Every Day



☐ Save up to 40 minutes with Jamesway feed truck.

☐ Save up to 30 minutes with Jamesway water cups.

☐ Save up to 50 minutes with Jamesway litter carrier.

☐ Save time and feed with Jamesway hog feeders.

See your Jamesway dealer first for quality products and service. For free literature, write Dept. HD-348.

James Manufacturing Company

ELMIRA, N. Y. FT. ATKINSON, WIS. OAKLAND, CALIF.

Look for the Store with the Jamesway Sign.

Reviews Ag Engineering Research

(Continued from page 176)

"Insect control: Bait mixers and distributors, uniform dust hoppers, abrasion testers, uniform nozzle distribution mechanism, and airplane dusters and sprayers.

"Apples and pears: Improvements in refrigerated storage facilities, warehouse and refrigerated (and heated) railway cars, motor trucks.

"In the solution of these problems those of us in public service research need the active cooperation of groups such as yours to enable us to do a better job for taxpayers who pay our salaries. An arrangement the farm equipment industry uses to keep in touch with our work might also be applicable by the National Canners Association. Farm Equipment Institute has an advisory committee on research that has met with us a number of times to become informed on the research facilities and projects of our Bureau. This committee has developed a list of research projects for consideration by state and federal agencies. It is also sponsoring research-industry conferences in representative states all across the country once or twice each year."

Research Notes

(Continued from page 167)

in the trough, except during extremely cold weather, when the by-passed water overflows into a standpipe drain to the pit below.

House D has a cone-shaped drinking cup attached to the end of a vertical supply pipe. It is known as the "Johnson drinker". The supply is maintained in the cup at all times by means of a floating inner cone. The water pipe and cone assembly were enclosed in a 4-in vitrefied tile around which was placed a 10-in tile and the space between them filled with a mica type of insulation. A mixture of portland cement and sand was used to seal the insulation at the top and bottom. No artificial heat was used during most of the season, but sufficient ice formed in the cone assembly to make it inoperative about three times without damage.

House E has only recently been equipped with an automatic supply. A cup type of drinker originally obtained from California has been installed and protected from freezing by means of a newly developed thermostatically controlled heating tape. The 20-ft length and 140-w heating capacity make it adaptable to the 8 ft of supply pipe and cup assembly. A square wash tub fitted with a drain in the bottom and a wire platform over the top serves to catch the water spilled by the birds and that wasted when the cup is cleaned.

During this 1947-1948 season all five installations have performed satisfactorily with regard to freezing protection. Data on temperature, water, and electric energy consumption are being obtained for comparative analysis. Considerations as to availability of materials and equipment, cost of installation, cost of operation and durability of the various units will be important in determining which of the five developments will be best suited to the small poultryman. In the opinion of those making the study, the "Johnson drinker" holds the most promise at the present time.

Considerations in Foreign Aid

(Continued from page 143)

our intelligent selection of the specific items which would be most helpful under their conditions rather than under ours.

In some of our previous foreign aid efforts we have forgotten this elementary fact, much to our discredit. To permit it to be forgotten again would be to condemn ourselves in multiple as poor humanitarians, poor custodians of our technology and its benefits, poor examples of human response to cultural advantages.

Another weakness in our previous foreign aid efforts was pointed out to the Senate Committee by True D. Morse, president, Doane Agricultural Service. The manner in which we have given that aid has failed to encourage the people concerned to do their own best to re-establish a sound self-supporting economy. Mr. Morse urged the Committee to "Put further European aid on an incentive basis. I find people very positive on this point. Farmers who work six and seven days a week in this country are not very tolerant of the reports of European miners and other laborers working only three days per week or only long enough to buy what their ration stamps permit."

Americans are not interested in simultaneously subsidizing both sides of any of the various class and ideological struggles common in Europe. They are not the kind of fights we like to see as exhibitions, at any price.

It should be apparent by this time that we cannot take for granted the constructive use of material aid furnished to other countries. We should make it clear that only a limited amount of such aid is available, and that it will be directed to the places where people show a will to cooperate in its effective use to re-establish a self-supporting economy. In some cases we may have to insist on their following our technological and business guidance in the use of the aid provided.

We claim no clear insight into the divine plan for populations which continually strain their means of subsistence to the suffering point, and further waste it in internal and aggressive wars. We do believe that America can and must improve its stewardship of the technological and material assets at its command to improve the lot of mankind, both here and abroad. Paul Mulliken and True Morse have clearly indicated two specific ways in which this can be done.

Additional Working Capital

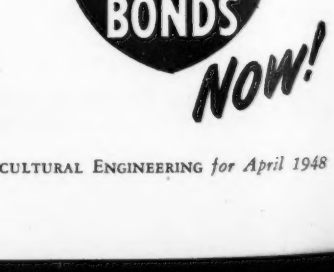
MANY established corporations today need additional working capital to provide for increasing production and distribution costs. Many need funds for expansion or modernization.

During the past twelve months a new economical method of raising capital by means of preemptive rights has been perfected. We have prepared a booklet which describes this new financing technique.

Upon request, we will be pleased to send a copy of our new booklet entitled "The Financing of Stock Issues with Preemptive Rights."

SHIELDS & COMPANY

44 Wall Street New York 5, N. Y.



HIGH STRENGTH NICKEL ALLOYS ASSURE *Extra Stamina* IN "SILVER KING" TRACTORS

"Silver King" Tractors are available in standard four wheel types, also.

Distinguished for power, speed and easy control, "Silver King" tractors incorporate the experience of Fate-Root-Heath Co., Plymouth, Ohio, gained in manufacturing sturdy machinery, including thousands of "Plymouth" industrial locomotives, during the past half-century.

Fate-Root-Heath has engineered long, trouble-free service life into the "Silver King" by making all vital parts of strong, tough, wear-resistant materials, including nickel-chromium cast irons, as well as nickel-chromium and nickel-chromium-molybdenum steels.

Bull wheel hubs, transmission cases, goosenecks (on the three-wheel type) are among "Silver King" parts cast in nickel-chromium iron. Moreover, the Continental engine that powers the machine utilizes nickel alloy iron to assure wear-resistance of the cylinder block and other vital castings.

In addition, stressed parts such as transmission gears and shafts, final drive pinions and drive shafts are of heat treated nickel-chromium or nickel-chromium-molybdenum steels. And the Timken roller bearings for transmission and rear axle are also heat treated nickel alloy steels.

The wide range of nickel alloys available, permits selecting one with extra qualities for any specific use. Send us details of your metal problem to obtain our recommendation. Write us today.

MORE SCRAP—MORE STEEL!...*Move your scrap now!*

Over the years, International Nickel has accumulated a fund of useful information on the properties, treatment, fabrication and performance of engineering alloy steels, stainless steels, cast irons, brasses, bronzes, nickel silver, cupro-nickel and other alloys containing nickel. This information is yours for the asking. Write for "List A" of available publications.

EMBLEM OF INCO SERVICE
TRADE MARK

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This equipment, produced by Livestock Sprayer Mfg. Co., of San Jose, Calif., operates through 25 nozzles, set to cover every portion of the animal's body, and forces powerful sprays against the grain of the hair, penetrating to the very pores of the hide. Assures complete saturation of every sq. in. of head and body with approved insecticide. Operating rate: 135 gals. per min., 5 to 8 seconds per animal, or 140 to 175 animals per hour.

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Planting on side of terrace with Farmall H Tractor at Hershey

INTERNATIONAL HARVESTER has long subscribed to the principle that if there is to be a "tomorrow" for both agriculture and industry, soil conservation practices must be carried out *today*.

To promote this modern farming, the company last fall held the fourth and fifth of a nation-wide series of In-Service Training Courses on farm machinery for Soil Conservation Service personnel. They were staged in Region Five, Lincoln, Nebr., and Region One, Hershey, Pa.

Thousands of interested persons attended these meetings to watch machines fight "land on the move." These men, supported by International Harvester and IH Dealers, form an army that is waging a great peace-time battle: the conservation of the land, our greatest heritage.

INTERNATIONAL HARVESTER COMPANY
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New Literature

FARM MACHINERY AND EQUIPMENT by H. P. Smith. Third edition. Cloth, XIII + 520 pages, 6x9 inches. Illustrated and indexed. McGraw-Hill Book Co. (New York 18) $5.00.

It has been ten years since publication of the second edition of this standard text and reference. Improvements in farm machinery during that time have been extensive. The third edition has been almost completely rewritten to cover machines and machine elements now in use or coming into use, and to eliminate material on older models rapidly disappearing from general use.

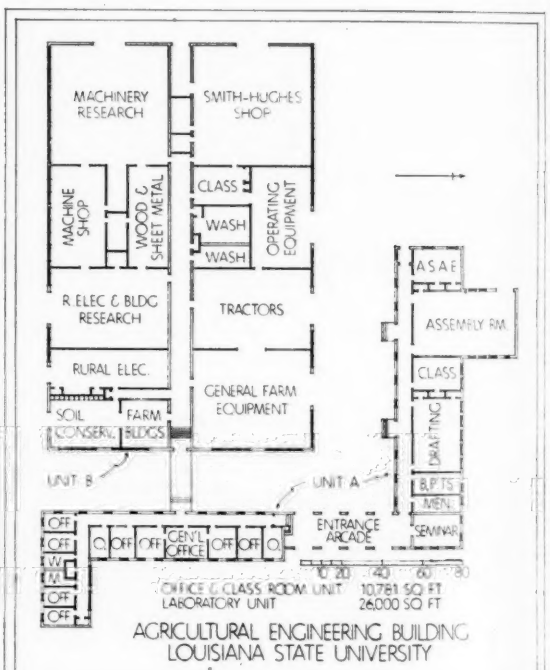
Chapters in the current edition are grouped into 17 parts covering importance of farm machinery to agriculture, principles of farm machinery, soil preparation machinery, seedbed preparation machinery, seeding machinery, cultivating machinery, dusting and spraying machinery, harvesting machinery, seed preparation machinery, feed preparation machinery, fertilizing machinery, transportation equipment, cleaning and grading machinery, soil and water conservation machinery, labor saving equipment, pasture machinery, and economics of farm machinery.

NATIONAL TRACTOR AND FARM IMPLEMENT BLUE BOOK (1948 edition). Paper, 160 pages, 4¼x6¼ inches. Illustrated and indexed. National Market Reports, Inc. (1315 S. Michigan Ave., Chicago 5, Ill.) $3.50. Appraisals and other trade data.

HANDBOOK OF THE BETTER FARM BUILDINGS ASS'N. Paper, 25 pages, 5¾x8½ inches, loose-leaf. (25 Elm St., Ardsley, New York). Organization, administration, and services of the association.

SAFETY IN FARM MECHANICS AND WITH FARM MACHINES. Rural Series Bulletin No. 2, Department of Rural Education, National Commission on Safety Education of the National Education Association (Washington 6, D. C.). Paper, 32 pages, 6x9 inches. Single copy price, 35 cents. Reduced prices on quantity orders.

A practical help for extension specialists and teachers of vocational agriculture.



Work has been started on the new agricultural engineering building at Louisiana State College, Baton Rouge, the floor plan of which is shown here. The floor plan is somewhat unconventional, and was given this form in order to take advantage of the slightly rolling site. Unit A is in two sections, one for offices and one for class instruction. There is a difference of 3 ft in the floor level of these sections, the office section being on the higher elevation. The assembly room has a stepped floor, and this results in a third floor level in Unit A as a whole. Connecting the two sections is an open arcade or archway which serves also as the main entrance to the building. Units A and B are connected by a covered walk with open sides. Unit B contains the various laboratories. The completed cost of the building and equipment will be approximately $312,000, and the expected date of completion will allow occupancy of the building at the beginning of the second semester in the school session, 1948-49.

Applicants for Membership

The following is a list of recent applicants for membership in the American Society of Agricultural Engineers. Members of the Society are urged to send information relative to applicants for consideration of the Council prior to election.

Albrecht, Carl F.—Assistant professor of agricultural engineering, Michigan State College, East Lansing, Mich.

Batson, Brax H.—Manager, equipment division, L. R. Barber Farms, Moultrie, Ga. (Mail) 710 Myrtle Lane.

Benjamin, Joel R.—President, Water Conservation Service Co., 545 West Smith Rd., Medina, Ohio.

Brevik, Theodore J.—Instructor (research) in agricultural engineering, Michigan State College, East Lansing, Mich.

Brown, Owen K.—Extension agricultural engineer, University of Idaho, Moscow, Idaho. (Mail) 118 South Hayes.

Cook, R. L.—Sales engineer in charge of irrigation dept., R. S. Armstrong & Bro. Co., 676 Marietta St., NW, Atlanta, Ga.

Dawn, George I.—Product engineer, Dearborn Motors Corp., 15050 Woodward Ave., Detroit, Mich.

DeBruin, W. H.—Development engineer, tractor and implement tires, Goodyear Tire & Rubber Co., Akron, Ohio.

Dube, LeRoy S.—Farm specialist, Haverhill Electric Co., 121-125 Merrimack St., Haverhill, Mass.

Evans, John S.—Assistant in agricultural engineering, Clemson Agricultural College, Clemson, S. C.

Eves, Par B.—Agricultural power specialist, Coast Counties Gas & Electric Co., 618 Main St., Watsonville, Calif.

Feeley, Mark T.—Assistant chief engineer, tractor div., Ford Motor Co., Dearborn, Mich. (Mail) 1320 Porter St.

Glover, W. R.—Instructor in agricultural engineering, Mississippi State College, State College, Miss. (Mail) P. O. Box 413.

Graham, W. T., Jr.—Buyer, farm equipment division, Montgomery Ward & Co., Chicago Ave. and Larrabee St., Chicago 7, Ill.

Hill, M. Russell—Service manager, Sherman Products Inc., 3200 W. 14th Mile Road, Royal Oak, Mich.

Huntington, E. H.—Sales dept., Whitney Chain & Mfg. Co. (Mail) 21 N. Loomis St., Chicago 7, Ill.

Jensen, E. Clem—Sales engineer, Mechanics Universal Joint Div., Borg-Warner Corp. (Mail) 2020 Harrison Ave., Rockford, Ill.

Magnusson, Knut—Farmer, Innisfail, Alberta, Canada.

Marshall, James—Sales engineer, Security Manufacturing & Contracting Co., Burlington, Wis. (Mail) Box 343.

Martin, George E.—Installation and service engineer, H. E. Robinson & Co., 4 Edward St., Port-of-Spain, Trinidad, B.W.I.

McCurdy, Joseph A.—Farm representative, Pennsylvania Power & Light Co., Lancaster, Pa. (Mail) 514 West Orange St.

Miller, Geo. E., Jr.—Assistant general ranch superintendent, E. Clemens Horst Co., P. O. Box 1024, Sacramento, Calif.

Moss, Roy I.—Chief project design engineer, Mount Vernon Implement Co., 230 East 8th St., Mt. Vernon, N. Y.

Reid, Crawford—Engineer and sales manager, Rain Bird Sprinkler Mfg. Corp., Glendora, Calif. (Mail) P. O. Box 37.

Stenholm, Frank A., Jr.—Assistant county agricultural agent, Lake City, Fla.

Thurmond, Robert V.—Assistant county agricultural agent, Texas Agricultural Extension Service, College Station, Tex.

Welden, C. D.—Division rural service engineer, Alabama Power Co. (Mail) Anniston, Ala.

Witt, Robert H.—Instructor in agricultural engineering, Oklahoma A. & M. College, Stillwater, Okla.

Woolsoncroft, Dale L.—Design engineer, John Deere Des Moines Works. (Mail) 117 Logan St., Ankeny, Iowa.

TRANSFER OF GRADE

Huber, Samuel G.—Instructor in agricultural engineering extension, Ohio State University, Columbus, Ohio. (Junior Member to Member)

Ratnatunga, D. M.—Associate agricultural engineer, Department of Agriculture, Dominion of Ceylon. (Mail) c/o Over-Seas House, London, S.W.I., England. (Junior Member to Member)

Resnick, Sol D.—1st Lt., Counter Intelligence Corps, U. S. Army. (Mail) 1624 W. Meinecke Ave., Milwaukee, Wis. (Junior Member to Member)

Roberts, William M.—Educational advisor, Pioneer Electric Cooperative, P. O. Box 401, Greenville, Ala. (Junior Member to Member)

Salter, Milo J.—Test engineer, tractor division, Allis-Chalmers Mfg. Co. (Mail) R. R. No. 1, West Bend, Wis. (Junior Member to Member)

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The new FARMALL CUB has dust protection by DONALDSON

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Personnel Service Bulletin

The American Society of Agricultural Engineers conducts a Personnel Service at its headquarters office in St. Joseph, Michigan, as a clearing house (not a placement bureau) for putting agricultural engineers seeking employment or change of employment in touch with possible employers of their services, and vice versa. The service is rendered without charge, and information on how to use it will be furnished by the Society. The Society does not investigate or guarantee the representations made by parties listed. This bulletin contains the active listing of "Positions Open" and "Positions Wanted" on file at the Society's office, and information on each in the form of separate mimeographed sheets, may be had on request. "Agricultural Engineer" as used in these listings, is not intended to imply any specific level of proficiency, or registration, or license as a professional engineer.

NOTE: In this Bulletin the following listings still current and previously reported are not repeated in detail. For further information see the issue of AGRICULTURAL ENGINEERING indicated.

Attention is invited to the desirability of checking on the housing situation when considering a new location.

POSITIONS OPEN: 1947 MARCH—O-543. APRIL—O-552. JUNE—O-569, 571. SEPTEMBER—O-581, 582. OCTOBER—O-588, 589. NOVEMBER—O-592. DECEMBER—O-597, 598, 599, 604. 1948 JANUARY—O-605, 606. FEBRUARY—O-607, 608. MARCH—O-609, 610, 611.

POSITIONS WANTED: 1947 FEBRUARY — W-373. May — W-398, 103. JUNE—W-106. SEPTEMBER—W-119, 120. 1948 JANUARY —W-135, 136, 137. FEBRUARY—W-138, 141, 142, MARCH—W-145, 146, 147, 148, 149, 150, 151, 152.

NEW POSITIONS OPEN

AGRICULTURAL ENGINEER to head research department of a southern farm equipment manufacturer. Work will be on peanut harvesting machinery and general tillage implements. Want man with 4 to 6 yrs experience in the research department of a major farm equipment manufacturing concern, and interested in living in southwestern Georgia and in rendering a service to the South. Unlimited opportunity for advancement. Age 30-40. Salary open. O-612

MECHANICAL ENGINEER for development work on high-pressure pumps and sprayers, and some supervision of small engineering department for manufacturer in New York State, with plant employing 200 people. Want man with experience in high-pressure pump and spray equipment engineering. Knowledge of tractors an advantage. Opportunity for advancement. Salary open. O-613

AGRICULTURAL ENGINEER (assistant professor), for teaching and research in farm power and machinery, soil and water, farm structures, and farm utilities, in agricultural engineering department of a state university in the Northeast. The teaching is to be on an engineering level. BS and MS deg in agricultural engineering, or equivalent. Want man with farm background and with some experience in academic or industrial work, or in both. Usual personal qualifications for college work. Normal opportunities for advancement. Twelve-month basis. Position to be filled by midsummer. Age, under 40. Salary $3700-4300. O-164

AGRICULTURAL ENGINEERS (several) for variety of openings in the engineering department of a manufacturing organization expanding its implement engineering work. Current openings for experienced project, field test, cost, design, and junior engineers. Midwest location. BS deg in agricultural engineering or equivalent, and experience as needed for position desired. Excellent opportunity for advancement. These openings are in addition to those being filled by promotion of qualified men within the organization. Good facilities, congenial organization, and management which appreciates the importance of good engineering. Salary open. Top salaries paid for the ability, experience and other qualifications desired. O-615

NEW POSITIONS WANTED

AGRICULTURAL ENGINEER desires work in power and machinery or rural electric field. BS deg in agricultural engineering expected June 1948. Experience as farmer one year, electrician short time, and in U. S. Navy, enlisted and commissioned, 3 yrs. No disability. Available July 1. Single. Age 23. Salary $2700-3000. W-153

AGRICULTURAL ENGINEER desires work in field of soil and water control or teaching and research. BS deg in agricultural engineering, with major in soil conservation, Louisiana State University, 1948. Experience as construction project clerk 4 yrs, engineering aide in Soil Conservation Service and U. S. Engineer Corps, 2 yrs., and in Navy enlisted and commissioned service 3½ years. No disability. Available June 1. Married. Age 28. Salary open. W-154

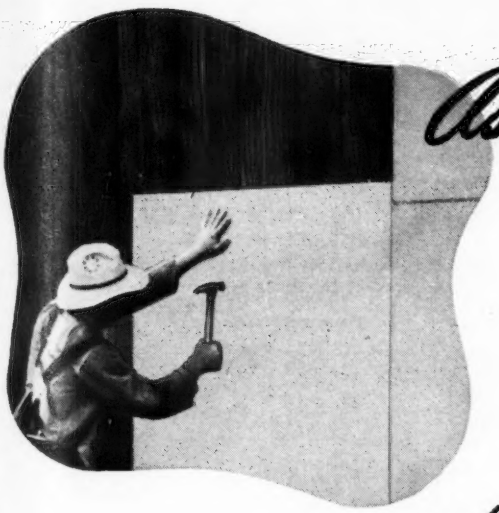
AGRICULTURAL ENGINEER desires teaching, extension, sales, service, or project engineering work in power and machinery, rural electrification, or farm structures field. BS deg in agricultural education and agricultural engineering, Michigan State College, 1941. MS deg in agricultural engineering and rural sociology, Michigan State College, 1946. Vocational agriculture teacher 7 yrs, including teaching farm shop courses, and 2 yrs as superintendent of schools. No disability. Available May 1. Married. Age 30. Salary $4000-$5000. W-155

AGRICULTURAL ENGINEER desires development, research, or sales work in power and machinery field, or irrigation work. BS deg in agricultural engineering expected May 1948, University of British Columbia. Experience in machine shop 2 yrs; and in farm labor and management, 2 yrs. No disability. Available June 1. Single. Age 25. Salary open. W-156

AGRICULTURAL ENGINEER desires design, development, or service work with private company in power and machinery field. BS deg in agricultural engineering expected June 1948, Michigan State College. Experience with Kuhlman Electric Co. in transformer manufacture, 4 yrs. One summer, drafting, Bay City Shovels. Part time drafting, agricultural engineering department, Michigan State College, 1946 to present. Army enlisted and non-commissioned experience 4 yrs. No disability. Available July 1. Married. Age 31. Salary open. W-157

(*Continued on page 184*)

For greater fire safety on the farm ...Johns-Manville Building Materials



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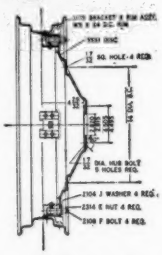

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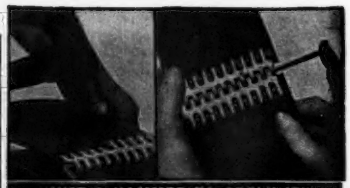

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By using Flexco HD Rip Plates, damaged conveyor belting can be returned to satisfactory service. The extra length gives a long grip on edges of rip or patch. Flexco Tools and Rip Plate Tool are used. For complete information ask for Bulletin F-100.

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RATES: Announcements under the heading "Professional Directory" in AGRICULTURAL ENGINEERING will be inserted at the flat rate of $1.00 per line per issue; 50 cents per line to A.S.A.E. members. Minimum charge, four-line basis. Uniform style setup. Copy must be received by first of month of publication.

PERSONNEL SERVICE BULLETIN

(*Continued from page* 182)

AGRICULTURAL ENGINEER desires developent, research, or service work in power and machinery or rural electric field. BS deg in agriculture, University of Toronto, 1935. Lifetime farm background in power machinery. Owned and operated general farm 10 yrs. Taught short courses in agricultural engineering at Ontario Agricultural College. No disability. Available June 1. Married. Age 35. Salary open. W-158

AGRICULTURAL ENGINEER desires research work in power and machinery with emphasis on chemical weed and grass control. BS deg in agricultural engineering, Mississippi State College, expected in May. Farm background and 3 yrs measuring land with Agricultural Adjustment Administration. War service, 3½ yrs in Army Air Force, including 2½ yrs as commissioned pilot. No disability. Available June 1. Married. Age 26. Salary open. W-159

AGRICULTURAL ENGINEER desires work in soil and water or farm structures field with private company. BS deg in agriculture with major in agricultural engineering expected in June, University of Wisconsin. Farm background. Active in FFA, 4-H, and vocational agriculture while in high school. War enlisted and noncommissioned service in Artillery, ASTP, and Air Force 4 yrs, including duty as airplane mechanic, instructor in airplane mechanics, supervisor, and in technical inspection. No disability. Available June 1. Married. Age 25. Salary open. W-160

AGRICULTURAL ENGINEER desires design, development, or research in power and machinery field with private company in midwestern or western location. BS deg in agricultural engineering, University of Nebraska, June 1941. Graduate work at Illinois Institute of Technology. MS deg in mechanical engineering (machine design), expected in June. Experience in tractor testing 1 yr, design, 6 yrs. War work on military tractor. Experienced in stress analysis, specifying materials, developing ideas, and supervising draftsmen. No disability. Available on one month notice. Married. Age 30. Salary open. W-161

AGRICULTURAL ENGINEER desires design and development work in power and machinery field. BS deg in agricultural engineering expected in June, Pennsylvania State College. Dairy farm background. One summer as timekeeper and laborer on highway construction. War service 3½ years in Air Corps communications. No disability. Available July 1. Married. Age 25. Salary open. W-162

AGRICULTURAL ENGINEER desires sales, research, or development work in rural electric or product processing field. BS deg in electrical engineering, University of Michigan, 1947. MS deg in agricultural engineering, Michigan State College, to be awarded in June. Requirements already completed. Farming four summers and part time in winters, 1937-41. Accounting 3 mo. Farm machinery cost survey in Michigan, 3 mo. Naval enlisted and commissioned service, 3 yrs, with engineering duty. No disability. Available now. Married. Age 24. Salary $3600-4000. W-163

AGRICULTURAL ENGINEER desires design, development, teaching, research, or project engineering, in power and machinery, soil and water, or product processing field. BS deg, 1939, Southwestern Institute of Technology. BS deg, 1946, Oklahoma A. & M. College. MS deg, 1947, A. & M. College of Texas. War commissioned service in U. S. Navy 3½ yrs. Experience in farm management, land clearing, and farm machine custom service, one year; research, SCS Hydraulic Laboratory, one year; teaching, in high school and college, 3½ yrs. No disability. Available May 1. Married. Age 30. Salary $4500. W-164

AGRICULTURAL ENGINEER desires teaching and research in agricultural engineering field. BS deg in agricultural education, 1947; BS deg in agricultural engineering, 1948, Ohio State University. Experience as carpenter 1½ yrs; farming 10 yrs; and industry 1¾ yrs (operation of large production equipment in close tolerance machining). War enlisted service in Signal Corps, including 16 months electrical training. No disability. Available July 1. Married. Age 28. Salary open. W-165